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MANUAL OF ANATOMY.

NUNQUAM ALIUD NATURA, ALIUD SAPIENTIA DICIT.

MANUAL

OF

PRACTICAL ANATOMY

BY

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VOLUME SECOND

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MANUAL OF ANATOMY.

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THORAX.

THE dissection of the thorax is commenced on the *eleventh* day[1] after the subject has been placed in the dissecting-room. By this time the upper limbs have been detached from the trunk.

In form the thorax resembles a truncated cone. In front and behind it is flattened; but laterally it is full and rounded. During life the movements of the thoracic walls produce alterations in the capacity of the chest cavity, and play an essential part in the function of respiration.

In front, the thoracic cavity is bounded by the sternum and costal cartilages; behind, it is bounded by the twelve dorsal vertebræ and the intervening cartilaginous discs, together with the portions of the ribs which extend outwards from the vertebral column as far as the angles; laterally, the shafts of the ribs, from their angles behind to their anterior extremities in front, limit the thoracic cavity. These parts constitute the framework of the thorax, and can be studied on the skeleton.

The anterior wall of the thorax is shorter than the posterior wall. Thus, during expiration, the upper margin of the manubrium sterni is placed opposite the disc between the second and third dorsal vertebræ, whilst the lower end of the body of the sternum corresponds in level with the middle point of the body of the ninth dorsal vertebra. The bodies of the dorsal vertebræ project forwards into the cavity of the thorax, and greatly diminish its antero-posterior diameter in the mesial plane; but on either side of the vertebral column, owing to the backward sweep of the posterior portions of the ribs, a deep hollow is formed for the reception of the most massive part of the lung.

---

[1] Saturdays and Sundays are not counted.

The superior aperture, or *inlet of the thorax*, is a narrow opening which is bounded by the first dorsal vertebra, the first pair of costal arches, and the manubrium sterni. The plane of this opening is very oblique; it slopes from behind forwards and downwards. Through the inlet of the thorax the apices of the lungs project upwards into the root of the neck, and between these the windpipe, gullet, the pneumogastric nerves, the gangliated cords of the sympathetic, and the great veins which carry blood towards the heart from the head and neck and the superior extremities enter the chest; through the same opening egress is given to the thoracic duct and to the arteries which convey blood to the neck, head, and upper limbs.

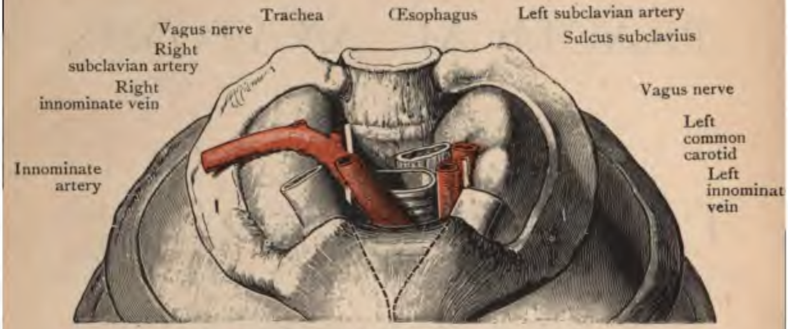
Trachea
Œsophagus
Left subclavian artery
Vagus nerve
Sulcus subclavius
Right subclavian artery
Right innominate vein
Vagus nerve
Left common carotid
Innominate artery
Left innominat vein

FIG. 1.—Cervical Domes of the Pleural Sacs, and parts in relation to them.

The base or dependent part of the thorax is very wide, and is sometimes called the *outlet*. In front it is bounded by the ensiform cartilage, and behind by the twelfth dorsal vertebra. Between these points the lower margin of the thorax presents a curved outline. Starting from the sternum, it proceeds downwards, outwards, and backwards along the cartilages of the seventh, eighth, ninth, and tenth ribs. At the tip of the eleventh rib the direction of the lower margin of the thorax changes, and it proceeds upwards, backwards, and inwards along the twelfth rib to the vertebral column.

Attached to the lower margin of the thorax is the *diaphragm*, a muscular partition which intervenes between the cavity of the chest above and the cavity of the abdomen below. It is highly vaulted or dome-shaped, and projects upwards so as to form a convex floor for the thorax, and a concave roof for the abdomen. The upward projection of the diaphragm greatly diminishes the vertical depth of the thoracic cavity.

But the diaphragm does not form an unbroken partition. It presents three large openings, by means of which structures pass to and from the thorax, viz.—(1) for the aorta, thoracic duct, and vena azygos major; (2) for the œsophagus and pneumogastric nerves; (3) for the inferior vena cava. Besides these there are other smaller apertures which will be mentioned later on.

THORACIC WALL.

Two days at least should be devoted to the dissection of the thoracic wall.

In addition to the osseous and cartilaginous framework, the walls of the chest are built up partly by muscles, and partly by membranes, and in connection with these there are numerous nerves and blood-vessels.

Muscles, . .	External intercostals. Internal intercostals. Triangularis sterni.
Membranes, . .	Anterior intercostal membranes. Posterior intercostal membranes. Pleural membrane (parietal part).
Nerves and Arteries,	Intercostal nerves. Aortic intercostal arteries. Superior intercostal artery. Internal mammary artery.

Dissection.—Portions of certain of the muscles of the upper limb and of the abdominal wall will be noticed attached to the thoracic wall. From before backwards the dissector will meet with the *pectoralis major*, the *pectoralis minor*, and the *serratus magnus*, whilst towards the lower margin of the chest he will recognise the *rectus abdominis* in front, and the *obliquus externus* and *latissimus dorsi* upon its lateral aspect. The rounded tendon of the *subclavius* may also be observed taking origin from the first costal arch, and posteriorly to this the *scalenus posticus* extends downwards to its insertion into the second rib. With the single exception of the scalenus posticus, these muscles should be removed so as to lay bare the costal arches and the intercostal muscles. In detaching the serratus magnus be careful not to injure the *lateral cutaneous nerves* which make their appearance in the intervals between its digitations. The *anterior cutaneous nerves* and *perforating branches* of the internal mammary artery must also be preserved; they pierce the origin of the pectoralis major in the intervals between the costal cartilages, and close to the margin of the sternum.

Intercostal Muscles.—These muscles occupy the eleven intercostal spaces on each side of the thoracic wall. In each space there are two strata of muscular fibres—a superficial and a deep. The superficial layer of muscular fibres is called the *external intercostal muscle*, and the deep layer the *internal intercostal muscle*.

The *external intercostal muscles* (musculi intercostales externi) are already exposed, and very little cleaning is necessary to bring out their connections. Observe that entering into their constitution there is a large admixture of tendinous fibres, and that these, as well as the muscular fibres, are directed from above, obliquely downwards and forwards from the lower border of the rib above to the upper border of the rib below. They do not extend farther forwards in the various spaces than a point corresponding to the union of the bony with the cartilaginous parts of the costal arches. In many cases, especially in the upper spaces, they do not reach so far. Here the muscular fibres stop short, but the tendinous fibres are prolonged onwards to the sternum in the form of a membrane, which may be called the *anterior intercostal membrane*. The external intercostal muscles of the two lower spaces are exceptions to this rule. They extend forwards to the extremities of the spaces. Posteriorly the muscles pass backwards as far as the tubercles of the ribs, but this is a point which can only be satisfactorily demonstrated after the thorax has been opened.

Dissection.—To bring the *internal intercostal muscles* into view it is necessary to reflect the external intercostal muscles, and also the anterior intercostal membranes. Divide them along the upper borders of the ribs which bound the spaces inferiorly, and throw them upwards. This dissection should be performed in each intercostal space, and, in effecting it, care must be taken of the intercostal arteries which lie between the two muscular strata.

The *internal intercostal muscles* (musculi intercostales interni) thus laid bare will be seen to be similar in their constitution to the external muscles. The fibres, however, run in the opposite direction—viz., from above, obliquely downwards and backwards. Superiorly, they are attached to the inner surface of the upper rib, immediately above the subcostal groove; inferiorly, they are attached upon the inner surface of the lower rib, close to the upper margin. The internal intercostal muscles are prolonged forwards to the sternum. Posteriorly they reach backwards to the angles of the ribs, from which to the spine the muscles are replaced by a series of thin membranes—the *posterior intercostal membranes*—which will be seen after the thorax has been opened. If the internal oblique muscle of the abdomen has not been removed, the dissector should note that the anterior fibres of the two lowest internal intercostal muscles become continuous with the fibres of that muscle.

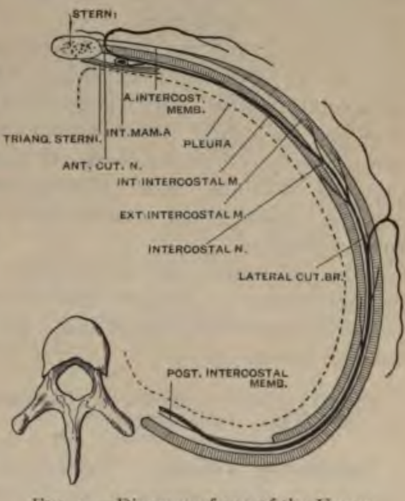

FIG. 2.—Diagram of one of the Upper Intercostal Nerves.

Intercostal Nerves.—The intercostal nerves are altogether out of sight in the present stage of the dissection. They are hidden by the lower borders of the ribs which bound the intercostal spaces superiorly. By gently pulling upon their lateral cutaneous branches they can be drawn downwards, and they are then seen to lie between the two muscular strata as far forward as a point midway between the spine and sternum. Here they disappear from view by sinking into the substance of the internal intercostal muscles, amidst the fibres of which they may be traced as far as the anterior extremities of the bony ribs. They now reach the deep surface of these muscles and are carried inwards, first upon the pleura, and then upon the triangularis sterni muscle. Lastly, they cross the internal mammary artery, and come forwards at the side of the sternum as the *anterior cutaneous nerves* of the pectoral region. Each nerve, before it reaches the surface, pierces—(*a*) the internal intercostal muscle; (*b*) the anterior intercostal membrane; (*c*) the origin of the pectoralis major; and (*d*) the deep fascia (Fig. 2).

But this description only holds good for the upper five intercostal nerves. The *lower six nerves*, on leaving the anterior ends of the intercostal spaces, pass forwards into the abdominal wall between the internal oblique and transversalis muscles, where they have already been displayed by the dissector of the abdomen.

The intercostal nerves, as they traverse the thoracic wall, give off—(*a*) the lateral cutaneous branches, (*b*) twigs to the intercostal muscles and triangularis sterni. Their terminal branches constitute the *anterior cutaneous nerves*. The *lateral cutaneous branches* come off midway between the spine and the sternum, and, piercing the external intercostal muscles, appear in the intervals between the digitations of the serratus magnus.

The first intercostal nerve gives off no lateral and no anterior cutaneous branch; the lateral cutaneous branch of the second intercostal nerve takes the form of the intercosto-humeral nerve.

It is not necessary to make a dissection of the intercostal nerves in more than two or three of the spaces.

Intercostal Vessels.—The intercostal arteries should be dissected in those spaces in which the nerves have not been traced, and in which, therefore, the internal intercostal muscles are still entire. It is only in a well-injected subject that a satisfactory view of these vessels can be obtained. In each intercostal space *one* artery is found passing from *behind forwards*; and in each of the upper nine intercostal spaces, *two*, the *anterior intercostal arteries*, running from *before backwards*.

In the upper two spaces the vessels which run from behind forwards are derived from the *superior intercostal branch* (truncus costo-cervicalis) of the subclavian artery; in the nine lower spaces they spring directly from the aorta, and are called the *aortic intercostal arteries*.

The *anterior intercostal arteries* of the upper six spaces proceed directly from the internal mammary, whilst in the case of the seventh, eighth, and ninth spaces they come from the outer of its two terminal branches—viz., the musculophrenic artery.

The intercostal vessels are for the most part distributed between the two muscular strata. From the angles of the ribs onwards to a point midway between the spine and sternum, the *aortic intercostal arteries* lie under shelter of the lower margins of the ribs which bound the spaces superiorly, and at a higher level than the corresponding nerves. Here each divides into two branches, and these pass forwards in relation to the upper and lower margins of the intercostal space. They give off small branches which accompany the lateral cutaneous nerves. The lower two aortic intercostal arteries are carried onwards beyond the thoracic wall into the abdominal wall. The *superior intercostal arteries* are disposed in a manner similar to the aortic intercostal vessels.

The *anterior intercostal arteries* are two in number for each space. At their origin they lie under cover of the internal intercostal muscles, and they run outwards in relation to the upper and lower margins of the ribs bounding each space. After a short course they pierce the internal intercostal muscles, and end by anastomosing with the aortic and superior intercostal arteries.

Dissection.—The dissector should next proceed to remove the intercostal muscles. This dissection must be carried out with more than usual care, because immediately subjacent to the internal intercostal muscles, over the greater extent of the chest wall, is the delicate pleural membrane lining the inner surface of the costal arches. *Upon no account detach this membrane from the deep surface of the ribs*, and take the greatest care to preserve it intact during the dissection.

On the front of the chest, the *internal mammary artery* and the *triangularis sterni muscle* will be seen to intervene between the pleura and the costal cartilages. The internal mammary artery, with its two companion veins, descends in a vertical direction, about half an inch from the outer margin of the sternum. Clean these vessels carefully in the intervals between the costal cartilages, and note some small lymphatic glands which lie along the course of the vessels. As a rule, the artery ends by dividing into two terminal branches in the interval between the sixth and seventh rib cartilages. Most likely this space will be so narrow that a view of the bifurcation cannot be obtained. If this be the case, pare away the edges of the cartilages over the artery, or if necessary remove the inner part of the sixth cartilage completely. The perforating branches of the internal mammary artery which accompany the anterior cutaneous nerves should be preserved.

The muscle upon which the internal mammary artery lies is the triangularis sterni. Endeavour to define its slips in the intervals between the costal cartilages.

Towards the lower margin of the thorax the pleural sac is not prolonged downwards to the lowest limit of the recess between the diaphragm and the costal arches. Indeed, in the axillary line, it will be found to fall considerably short of this. Consequently, when the internal intercostal muscles are removed from this portion of the chest wall, the dissector will come down directly upon the diaphragm; and, as the fibres of the diaphragm correspond somewhat in their direction with those of the internal intercostal muscles, it is no uncommon occurrence for the student to remove them, and thus expose the peritoneum, under the impression that he has simply laid bare the pleura. When the dissection has been properly executed, a strong fascia will be observed to pass from the surface of the diaphragm on to the surface of the costal pleura so as to hold it in position. Preserve this for further examination.

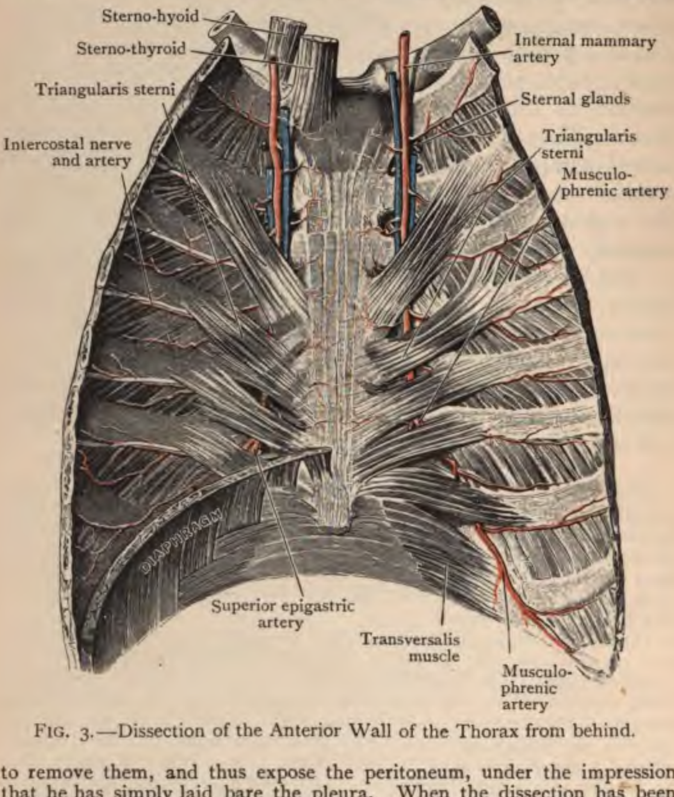
Sterno-hyoid
Sterno-thyroid
Triangularis sterni
Intercostal nerve and artery
Internal mammary artery
Sternal glands
Triangularis sterni
Musculo-phrenic artery
DIAPHRAGM
Superior epigastric artery
Transversalis muscle
Musculo-phrenic artery

FIG. 3.—Dissection of the Anterior Wall of the Thorax from behind.

Internal Mammary Artery (arteria mammaria interna).—This vessel arises in the root of the neck from the first part of the subclavian, and enters the thorax, by passing downwards behind the inner end of the clavicle and the cartilage of the first rib. Accompanied by two veins, it descends to the interval between the sixth and seventh costal cartilages, where it ends by dividing into the *superior epigastric* and the *musculo-phrenic branches.* It runs parallel with the outer margin of the sternum, from which it is separated by an interval of about half an inch.

Placed *in front* of the internal mammary artery are the upper six costal cartilages, with the intervening intercostal muscles and anterior intercostal membranes. It is crossed by the series of intercostal nerves before they turn forwards to gain the surface. In the upper part of its course the artery is supported behind by the pleura, but lower down it rests upon the triangularis sterni, which intervenes between it and the pleural sac.

In addition to its two terminal branches, a large number of small collateral twigs proceed from the internal mammary—

1. The anterior intercostal, .	to the thoracic parietes.
2. The perforating, . .	
3. The comes nervi phrenici,	to parts in the interior of the thorax.
4. Mediastinal and thymic, .	
5. Superior epigastric, .	the terminal branches.
6. Musculo-phrenic, . .	

The *anterior intercostal arteries* (rami intercostales) are supplied to the upper six intercostal intervals, and have already been dissected (p. 6). Two are given to each space: frequently these arise by a common trunk.

The *perforating arteries* (rami perforantes) accompany the anterior cutaneous nerves, and reach the surface by piercing the internal intercostal muscles, the anterior intercostal membranes, and the pectoralis major muscle. One, or perhaps two, are given off in each intercostal space. And in the female two or three of the intermediate members of the series (rami mammarii) attain a special importance, inasmuch as they constitute the principal arteries of supply to the mammary gland.

The *superior epigastric artery* (arteria epigastrica superior) enters the sheath of the rectus muscle of the abdominal wall by passing downwards behind the seventh costal cartilage.

The *musculo-phrenic artery* (arteria musculo-phrenica) turns outwards and downwards along the costal origin of the diaphragm and behind the rib-cartilages. Opposite the eighth costal cartilage it pierces the diaphragm and terminates on its abdominal surface. It gives off the *anterior intercostal arteries* to the seventh, eighth, and ninth intercostal spaces (p. 7).

Triangularis Sterni (musculus transversus thoracis).—This is a thin muscular layer placed on the deep surface of the sternum and costal cartilages. It is continuous below with the transversalis muscle of the abdominal wall, and arises from the posterior surface of the ensiform cartilage, the lower part of the body of the sternum, and from the inner ends of the 5th, 6th, and 7th costal cartilages. From this origin its fibres radiate in an upward and outward direction, and separate into five slips, which are inserted into the deep surfaces and lower borders of the 2nd, 3rd, 4th, 5th, and 6th costal cartilages, close to their junction with the ribs (Fig. 3).

In many cases the muscle is feebly developed, and does not show connections so wide as those which are described above. Upon the superficial aspect of the triangularis sterni are placed the internal mammary artery and the series of intercostal nerves.

It is only a partial view of the muscle which is obtained in the present dissection, but it is not advisable to remove the costal cartilages to expose it further, as this would materially interfere with the subsequent display, in their proper relations, of other more important structures.

THORACIC CAVITY.

The arrangement of the two pleural sacs must now engage the attention of the student; but in order that the relations of these may be understood, it is necessary that the dissector should have some preliminary knowledge of the thoracic cavity and its contents. The principal viscera of the chest are the lungs and the heart. The two *lungs* occupy by far the greatest part of the space, and lie one upon either side of the mesial plane. The *heart* is placed between the lungs, and projects more into the left than the right side of the cavity. It is completely enveloped by a loose conical fibro-serous sac called the *pericardium*, which is attached by its base to the upper surface of the diaphragm. Each lung is connected with the base of the heart by several large vessels which pierce the pericardium, and these, with the corresponding division of the windpipe passing to the lung, constitute the *pulmonary root* or *pedicle*. Each lung is free within the thorax except where it is attached by its root and by a fold of pleural membrane which will afterwards be described under the name of the *ligamentum latum pulmonis.*

The thoracic cavity is subdivided into two large lateral chambers which contain the lungs by a central vertical partition called the *mediastinum thoracis.* This partition extends from the anterior thoracic wall in front to the vertebral column behind, and from the fact that both sides of it, as well as the other walls of the lateral chambers, are lined by two serous membranes called the *pleuræ*, the chambers receive the name of the *pleural cavities.*

The mediastinal partition is built up of the several structures which lie in or close to the mesial plane. The more important of these are the heart enveloped in its pericardium, the thoracic aorta with the branches which spring from its arch, the pulmonary vessels and great veins in the neighbourhood of the heart, the trachea, the gullet, and the thoracic duct and the vagus and phrenic nerves.

The mediastinum is not median in position. Owing to the marked projection of the heart to the left side and to the position of the descending thoracic aorta on the left side of the bodies of the vertebræ, the left pleural chamber, although it is deeper than the right, is considerably reduced in width. The two pleural cavities, therefore, are not symmetrical in form.

Pleural Sacs.—The pleural sacs are two in number, one in each side of the chest cavity. They are serous sacs, and therefore closed. Each pleural bag is so disposed that it not only lines the chamber in which the lung lies, but is also reflected over the lung so as to give to it an external covering, which is intimately connected with the pulmonary substance. We recognise, therefore, in connection with each pleura a *lining* or *parietal part*, and an *investing* or *visceral part.* It must be clearly understood, however, that these terms are merely applied to indicate different portions of one continuous membrane.

The dissection which has already been made shows the pleura lining the deep surface of the costal arches and internal intercostal muscles. This portion is called the *pleura costalis.* The manner in which the pleura of each side is reflected backwards from the posterior aspect of the sternum must now be investigated. This entails a somewhat complicated dissection.

Dissection.—The sternum must be divided with the saw into four portions by three separate cuts, viz. (1) a transverse section through the manubrium sterni, on a line with the *lower* margins of the first pair of costal cartilages; (2) a transverse cut through the lower part of the body of the sternum, in the interval between the *fifth* and *sixth* costal cartilages; (3) an oblique section, beginning below at the inferior transverse cut, close to the left margin of the sternum, and carried upwards to the middle of the superior transverse cut. By the last section the central portion of the sternum is divided into two lateral pieces, to each of which four costal arches are attached (Fig. 4).

In making these sections through the sternum, the saw should only be used until the thick periosteum on the back of the bone is reached. This can then be divided cautiously with the knife. Of course the internal mammary vessels must be preserved, and care must be taken not to separate the parietal pleura at any point from the deep surface of the thoracic wall.

Anterior Mediastinal Space.—The two lateral portions of the central piece of the sternum should now be gently separated from each other, and, on looking between them, the parietal pleura of each side will be seen leaving the posterior surface of the sternum, and passing backwards to reach the pericardium. But the pericardium is not in view, except perhaps to a small extent below, because the two pleural membranes, where they make this reflection, are in contact. Introduce the finger between the two pleural sacs, and pass it upwards and downwards through the loose areolar tissue which holds them together. The pericardium is in this way exposed, and a demonstration is obtained of a space which is termed the *anterior mediastinal space*. *In front* this space is bounded by the posterior surface of the body of the sternum, and usually also by the inner ends of the fifth, sixth, and seventh costal cartilages of the left side, clothed by the left triangularis sterni muscle; *behind*, by the pericardium; and *upon each side*, by the pleura as it passes from the back of the sternum to the front of the pericardium. In its upper part the space can hardly be said to exist, seeing that the pleural sacs are in contact; but below, the left pleura falls somewhat short of the right pleura, and an interval is

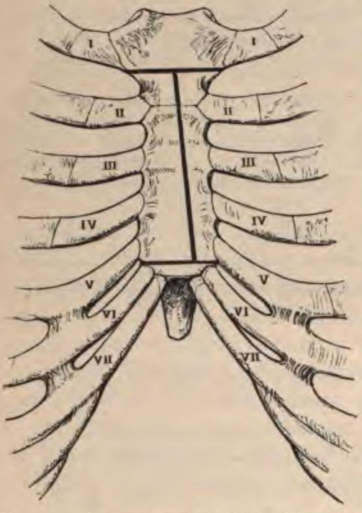

FIG. 4.—Lines along which the Sternum should be divided.

apparent. The only contents to be noticed in the anterior mediastinum are, in its lower part, a few small lymphatic glands and some loose areolar tissue, in which ramify lymphatic vessels and some minute arterial twigs from the internal mammary artery.

Dissection.—Having now ascertained the relations of the pleura to the chest wall, proceed to the study of its other connections within the thorax. For this purpose the parietal pleura must be separated from the ribs as far forwards as the cartilages. This can best be done by gently insinuating the forefinger between each of the ribs and the pleura, and then running it backwards and forwards. Upon no account detach the pleura from the cartilages. Next divide with the knife the *second*, *third*, *fourth*, *fifth*, and *sixth* costal arches at the junction of the osseous with the cartilaginous portions, and remove these ribs by snipping through them with the bone pliers as far back as possible. The sternum and cartilages, to which the pleura is still adherent, must be left in position until the arrangement of the membrane has been thoroughly investigated.

The greater part of the costal pleura now lies flaccid upon the surface of the lung. Make a vertical incision through it, midway between the spine and sternum, from the level of the second costal arch down as far as the seventh rib. From each extremity of this vertical cut carry an incision forwards for two or three inches.

Relations of the Pleura.—A considerable piece of the parietal pleura can now be thrown forwards like a door, and the interior of the pleural sac is exposed. The inner surface of the membrane, if healthy, presents an appearance which is characteristic of all serous membranes. It is smooth, polished, and glistening, and is moistened by a small amount of serous fluid. It is thus admirably adapted to allow the movements of the lung during respiration to take place with the smallest possible degree of friction. When the surface of the membrane becomes roughened by inflammatory exudation, the so-called "friction sounds" of pleurisy become evident when the ear is applied to the chest.

Introduce the hand into the pleural sac, and explore its extent and connections. First carry it inwards behind the costal cartilages. Its passage across the mesial plane of the body is effectually barred by the reflection of the pleural membrane from the back of the sternum to the corresponding side of the mediastinal partition. Above the level of the pericardium it passes right back upon the upper part of the mediastinal partition to the vertebral column, and then proceeds outwards on the ribs. Upon that part of the mediastinal partition which is formed by the lateral aspect of the pericardium it can be traced backwards towards the spine, and here it must be studied from two points of view, viz. (1) at the level of the root of the lung, and (2) below the root of the lung.

At the level of the pulmonary root, the pleura is carried outwards, so as not only to envelop this, but also the entire lung. The smooth glistening surface of the organ is due to the pleural investment which it thus acquires. This, then, is the *visceral pleura*, and it should be noticed that it is very much finer and thinner than the parietal pleura. Further, it is inseparably attached to the pulmonary substance. Behind the root of the lung the pleura is prolonged backwards upon the pericardium, and on the left side over the descending thoracic aorta to the bodies of the vertebræ. On the right side it passes from the pericardium over the œsophagus to the bodies of the vertebræ. This can be seen by tilting forwards the thick posterior border of the lung. From the vertebræ, the pleura passes outwards upon the deep surfaces of the ribs.

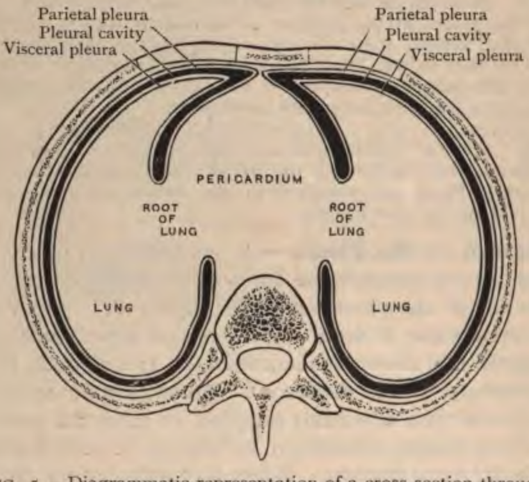
Parietal pleura
Pleural cavity
Visceral pleura
Parietal pleura
Pleural cavity
Visceral pleura
PERICARDIUM
ROOT OF LUNG
ROOT OF LUNG
LUNG
LUNG

FIG. 5.—Diagrammatic representation of a cross section through the two Pleural Sacs.

Below the level of the root of the lung, the pleura can be traced backwards upon the pericardium to the spine, from which it is conducted outwards upon the ribs. But it does not pass backwards uninterruptedly.

The same two layers which envelop the pulmonary root are prolonged outwards from the pericardium in apposition

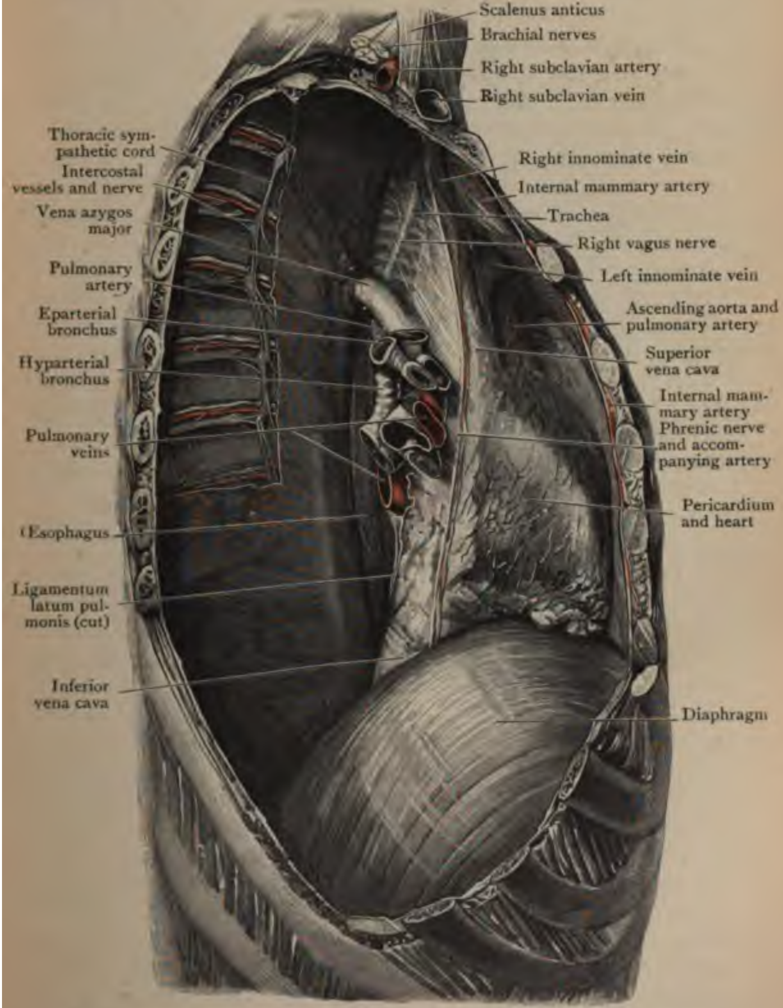
Scalenus anticus
Brachial nerves
Right subclavian artery
Right subclavian vein
Thoracic sympathetic cord
Intercostal vessels and nerve
Vena azygos major
Pulmonary artery
Eparterial bronchus
Hyparterial bronchus
Pulmonary veins
Œsophagus
Ligamentum latum pulmonis (cut)
Inferior vena cava
Right innominate vein
Internal mammary artery
Trachea
Right vagus nerve
Left innominate vein
Ascending aorta and pulmonary artery
Superior vena cava
Internal mammary artery
Phrenic nerve and accompanying artery
Pericardium and heart
Diaphragm

FIG. 6.—The Right Pleural Chamber opened up by the removal of its outer wall. The lung has been taken away so as to expose the mediastinal wall of the pleural chamber. Several of the structures in the mediastinal septum are seen shining through the mediastinal pleura.

with each other. Meeting the inner surface of the lung, they separate to enclose the lower portion of this organ. The fold of pleura which is thus formed is called the *ligamentum latum pulmonis*, and it can be brought into view by enlarging the opening in the pleural sac, and drawing the basal portion of the lung outwards and backwards. It will then be seen to be a fold which stretches between the pericardium and the lower part of the inner surface of the lung, and which presents a free border below.

The dissector has now traced the continuity of the pleural sac in the transverse direction. He has observed that it lines the deep surface of the costal arches, and is reflected backwards upon the surface of the intra-thoracic mediastinal partition from the back of the sternum to the spine. This portion is called the *mediastinal pleura*, and it is uninterrupted, except where it is pushed outwards over the lung and lung-root in the form of an investment. But the continuity of the membrane in a longitudinal direction must also be established. This inquiry will render clear its relations in the upper and lower parts of the thoracic cavity.

In the upper part of the chest cavity, the pleura will be observed to extend upwards through the thoracic inlet into the root of the neck, and to form in this locality a dome-shaped roof for each side of the chest (Fig. 11). This portion of the pleura is called the *cervical pleura*. Its summit or highest point reaches the level of the lower border of the neck of the first rib; but owing to the obliquity of the first costal arch this point is placed from one to two inches above the anterior extremity of the first rib, and from a half to one and a half inches above the clavicle. The subclavian artery arches over and lies in a groove on the inner and anterior aspect of this *cul-de-sac* near its summit, whilst at a lower level the innominate and subclavian veins also lie upon its inner and anterior aspects. The cervical dome of pleura is supported on its outer side by the scalenus anticus and scalenus medius muscles, and is strengthened by an aponeurotic expansion (*Sibson's fascia*) which is spread over it, and receives attachment to the inner concave margin of the first rib. This fascia is derived from a small muscular slip which takes origin from the transverse process of the seventh cervical vertebra. It may be regarded as a derivative from the scalene group of muscles.

In the lower part of the thorax the parietal pleura is reflected from the inner surface of the chest wall on to the

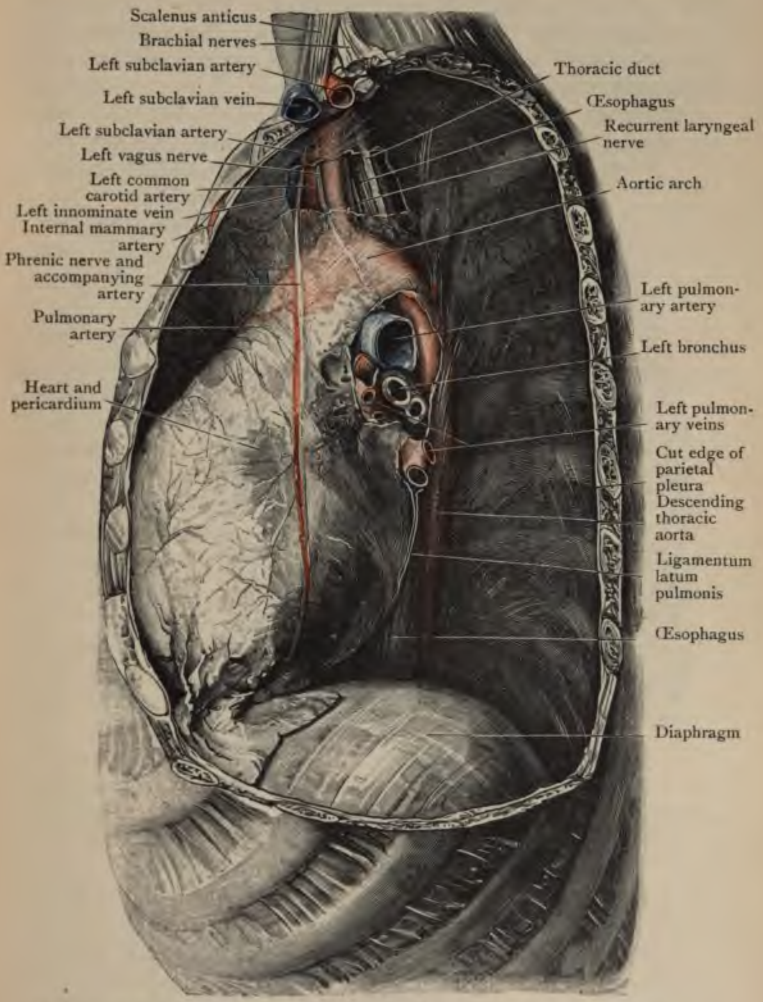
Scalenus anticus
Brachial nerves
Left subclavian artery
Left subclavian vein
Left subclavian artery
Left vagus nerve
Left common carotid artery
Left innominate vein
Internal mammary artery
Phrenic nerve and accompanying artery
Pulmonary artery
Heart and pericardium
Thoracic duct
Œsophagus
Recurrent laryngeal nerve
Aortic arch
Left pulmonary artery
Left bronchus
Left pulmonary veins
Cut edge of parietal pleura
Descending thoracic aorta
Ligamentum latum pulmonis
Œsophagus
Diaphragm

FIG. 7.—The Left Pleural Chamber opened up by the removal oi its outer wall. The lung has been taken away and a window has been made into the superior mediastinum by the removal of a portion of the mediastinal pleura. Several of the structures which form the mediastinal partition are seen shining through the mediastinal pleura.

upper surface of the diaphragm, and is carried inwards upon this towards the base of the pericardium, where it becomes continuous with the mediastinal pleura. The portion of the membrane which clothes the diaphragm is termed the *diaphragmatic pleura*.

Lines of Pleural Reflection.—The two pleural sacs are not shaped alike. The chambers which they line are not symmetrical, and consequently the lines along which the two membranes are reflected from the sternum and costal cartilages backwards towards the pericardium, and also from the chest wall on to the diaphragm, differ somewhat on the two sides.

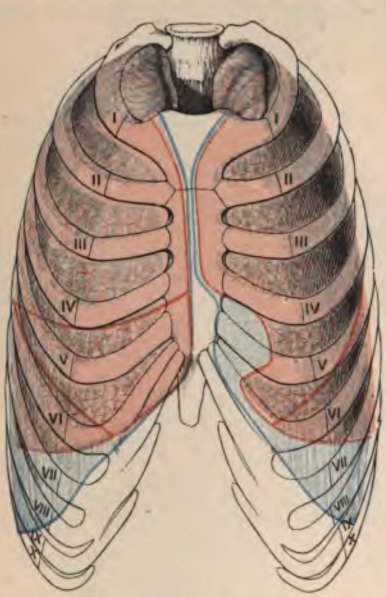

FIG. 8.—Diagram to show the relation of the lungs and the pleural sacs to the anterior thoracic wall. The lungs are depicted in red, and the pleural sacs in blue.

First consider the *sternal line of reflection*, or that along which the pleura leaves the anterior thoracic wall to become the mediastinal pleura. Behind the manubrium sterni the two pleural sacs are separated from each other by an angular interval, but near the upper end of the gladiolus they come together, and proceed downwards in close contact, and slightly to the left of the mesial plane, as far as the sternal end of the fourth costal cartilage. At this level the two sacs part company. The left pleura deviates outwards, whilst the right pleura is continued downwards in a straight line behind the sternum to the back of the ensiform cartilage. Here it turns sharply outwards, and, running obliquely downwards and backwards upon the deep surface of the seventh costal cartilage, is reflected from this on to the upper surface of the diaphragm.

Opposite the sternal end of the fourth costal cartilage the left pleura retires in an outward direction from the right pleura, and descends at a variable distance from it, so as to leave a small triangular portion of the pericardium uncovered by pleura, and in direct contact with the anterior chest wall.

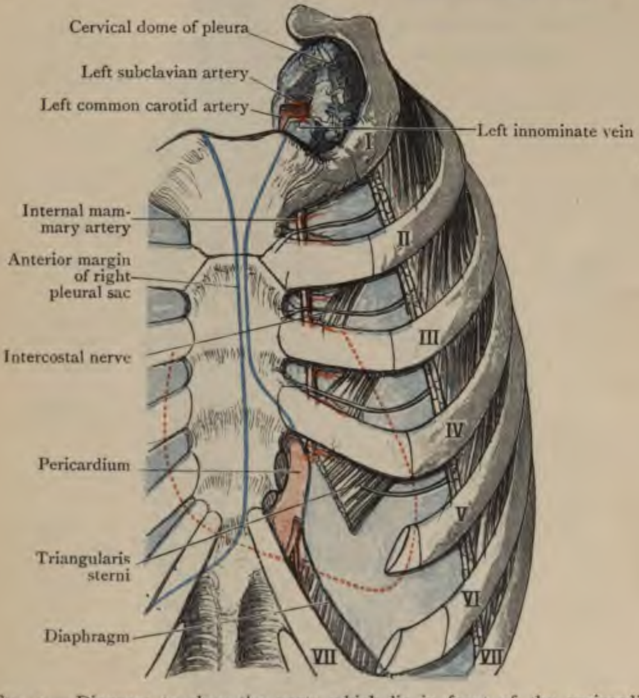
Cervical dome of pleura
Left subclavian artery
Left common carotid artery
Left innominate vein
I
Internal mammary artery
II
Anterior margin of right pleural sac
III
Intercostal nerve
IV
Pericardium
V
Triangularis sterni
VI
Diaphragm
VII
VII

FIG. 9.—Diagram to show the parts which lie in front of the pericardium and heart. The outline of the heart is indicated in red by a dotted line, and the anterior margins of the pleural sacs are represented by blue lines.

This area is very variable in its extent, but the accompanying diagram (Fig. 8) may be considered to represent the average amount of outward deviation of the left pleural sac in connection with this part of the chest wall.

Leaving the sternum, the reflection-line of the left pleura descends parallel and close to the left margin of the sternum behind the fourth intercostal space, the fifth costal cartilage, and the fifth intercostal space to the back of the sixth costal cartilage. Here it turns outwards and downwards and passes into the diaphragmatic reflection-line.

The *diaphragmatic reflection-line* is that along which the pleura leaves the thoracic wall and is reflected on to the upper surface of the diaphragm. This reflection takes place along a curved line which, except behind as it approaches the vertebral column, is placed a short distance above the lower

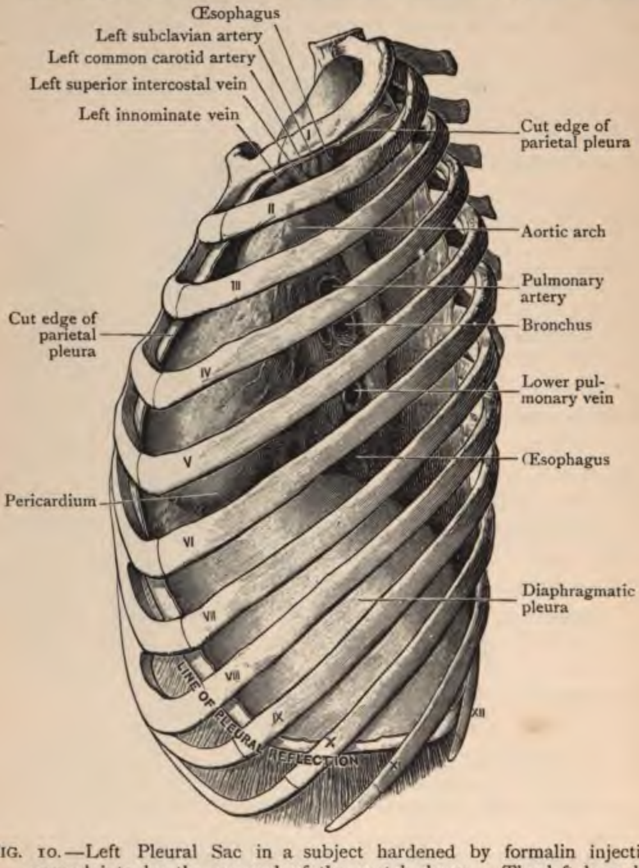
Œsophagus
Left subclavian artery
Left common carotid artery
Left superior intercostal vein
Left innominate vein
Cut edge of parietal pleura
Aortic arch
Pulmonary artery
Bronchus
Lower pulmonary vein
Œsophagus
Diaphragmatic pleura
Cut edge of parietal pleura
Pericardium
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
XII
LINE OF PLEURAL REFLECTION

FIG. 10.—Left Pleural Sac in a subject hardened by formalin injection opened into by the removal of the costal pleura. The left lung has also been removed so as to display the mediastinal pleura. The line along which the pleura is reflected from the diaphragm on to the thoracic wall is exhibited.

border of the thoracic wall. It differs slightly on the two sides of the body. On the *left side* the diaphragmatic line of reflection proceeds downwards and outwards behind the

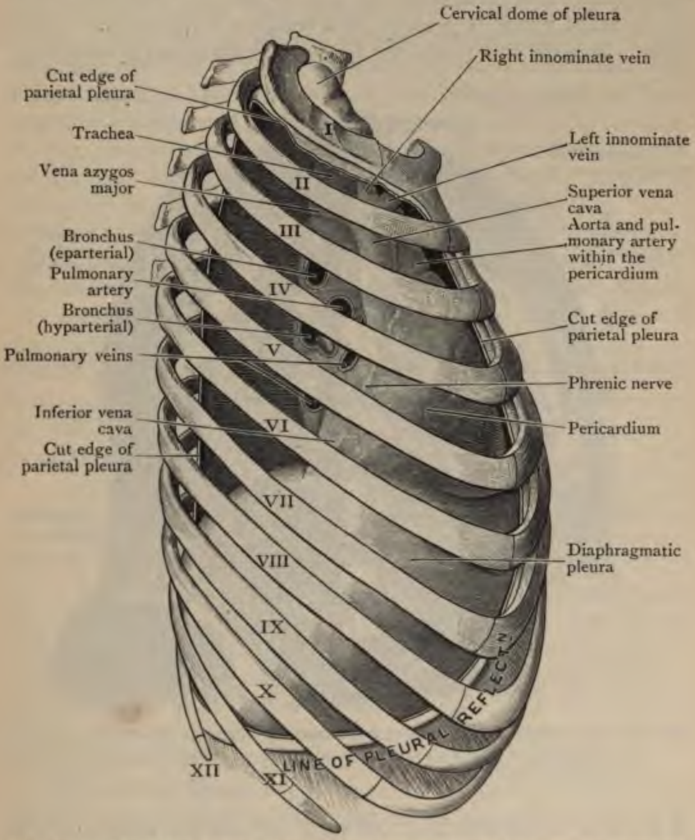
Cervical dome of pleura
Right innominate vein
Cut edge of parietal pleura
Trachea
Left innominate vein
Vena azygos major
Superior vena cava
Aorta and pulmonary artery within the pericardium
Bronchus (eparterial)
Pulmonary artery
Bronchus (hyparterial)
Cut edge of parietal pleura
Pulmonary veins
Phrenic nerve
Inferior vena cava
Pericardium
Cut edge of parietal pleura
Diaphragmatic pleura
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
XII
LINE OF PLEURAL REFLECTN

FIG. 11.—The Right Pleural Sac in a subject hardened by formalin injection opened into by the removal of the costal part of the parietal pleura. The right lung has also been removed so as to display the right mediastinal pleura. Note the line of diaphragmatic reflection of the pleura.

ascending part of the sixth costal cartilage, crosses behind the anterior end of the sixth intercostal space and the descending part of the seventh costal cartilage. Still continuing to descend, it passes behind the eighth costal arch at the junction between its cartilaginous and bony parts. This is a fairly constant relation on both sides of the body, and it should be noted that a vertical line drawn downwards from the nipple (mammillary line) intersects the line of pleural reflection close to the point where it presents this relation to the eighth costal arch. Beyond this point the line of diaphragmatic reflection

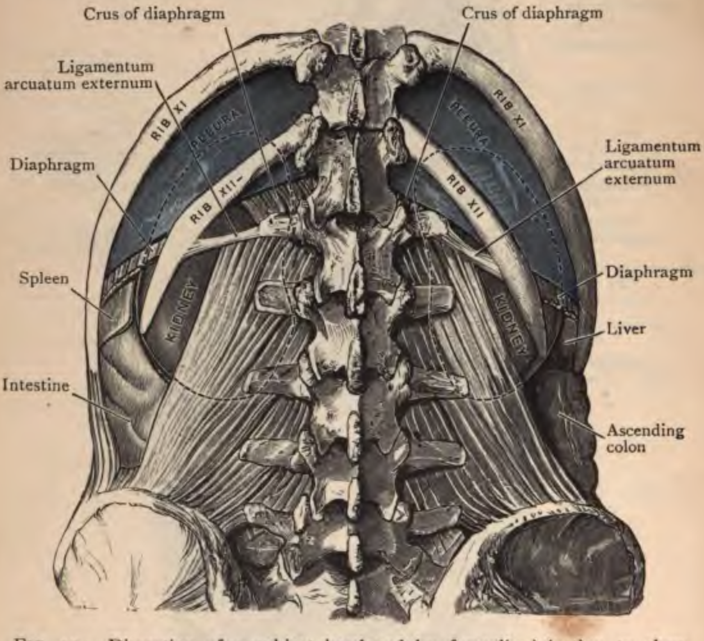
Crus of diaphragm
Crus of diaphragm
Ligamentum arcuatum externum
RIB XI
PLEURA
PLEURA
RIB XI
Ligamentum arcuatum externum
Diaphragm
RIB XII
RIB XII
Spleen
KIDNEY
KIDNEY
Diaphragm
Liver
Intestine
Ascending colon

FIG. 12.—Dissection of a subject hardened by formalin injection to show the relations of the Pleural Sacs posteriorly; more especially to the kidneys and last ribs.

is carried downwards and outwards across the extremities of the bony portions of the ninth and tenth ribs. As it passes under cover of the tenth rib, or it may be as it proceeds across the tenth intercostal space, the line of pleural reflection reaches its lowest point, and it is important to observe that this point lies in the mid-lateral line (*i.e.*, a vertical line drawn downwards on the side of the chest midway between spine and sternum). From this it curves slightly upwards as it proceeds backwards to the spine. Thus it cuts across the eleventh rib and reaches the twelfth rib. The relation which it presents to the twelfth rib varies in accordance with the length of that bone. When the rib is not unusually short, the pleura clothes its inner half and the line of reflection falls below this portion of the rib so as to meet the spine midway between the head of the last rib and the transverse process of the first lumbar vertebra. Here therefore the line of diaphragmatic reflection falls below the lower border of the thoracic wall, and this is a point of high practical importance. In operations on the kidney the incision cannot be carried above the level of the transverse process of the first lumbar vertebra and the ligamentum arcuatum externum without the risk of wounding the pleura (Fig. 12).

On the *right side* the line of diaphragmatic pleural reflection differs from that on the left side chiefly in front. Here it descends to a lower level. Thus it proceeds outwards behind the ascending part of the seventh costal cartilage, but it cuts the eighth costal arch, as a rule, at the same point as on the left side, viz., at the junction between its cartilaginous and bony portions. From this backwards to the spine the relations are so similar to those of the left side that a separate description is unnecessary.

It is commonly stated that the left pleural sac reaches a lower level than the right. This is by no means the rule. In those cases where the two pleural sacs do not reach the same level at their lowest points it is sometimes the right and sometimes the left pleura which oversteps the mark.

In the dissection of the intercostal spaces a strong fascia has been observed to pass from the uncovered part of the diaphragm and from the costal cartilages to the surface of the costal pleura along the line of diaphragmatic reflection. It may be compared with *Sibson's fascia*, which covers the cervical pleura, but is more strongly marked and more tendinous in character. It may be termed the *phrenico-pleural fascia.*

Mediastinal Space.—The term *mediastinal space* is applied to the interval which is left between the two pleural sacs. It is within this space that by far the greater part of the dissection of the thorax has to be conducted, and, consequently, it is important that the student should acquire an accurate conception of its extent and connexions. We have noted that the mediastinal portion of the pleura extends backwards from the front wall of the thorax on either side of the mesial plane, on the surface of the intra-thoracic mediastinal partition. This forms the lateral boundary of the space, whilst in front it is bounded by the sternum, and behind by the vertebral column. But it is customary to subdivide in an arbitrary manner the mediastinal space into four portions, termed respectively superior, anterior, middle, and posterior, according to the relations which they present to the pericardium.

Superior Mediastinum.—This is the part of the general mediastinal space which lies above the level of the pericardium. Its *boundaries* are the following:—*In front*, the manubrium sterni, to the posterior aspect of which are attached the lower ends of the sterno-hyoid and sterno-thyroid muscles; *behind*, the upper four dorsal vertebræ with the longus colli muscles; *below*, an imaginary and oblique plane extending from the lower border of the manubrium sterni backwards and upwards to the lower border of the fourth dorsal vertebra; and *laterally*, the mediastinal pleura as it extends on each side from the back of the sternum to the vertebral column.

Figs. 38 and 40 (pp. 68 and 71) are reproduced from tracings of two sections through the superior mediastinum at different levels. Fig. 40 represents a section through its upper part, and Fig. 38 a section through its lower part at the level of the fourth dorsal vertebra. The boundaries, form, and contents of the space are clearly seen.

Within the superior mediastinum are placed—(1) the aortic arch, and the three great vessels which spring from it; (2) the innominate veins and the upper part of the superior vena cava; (3) the trachea, gullet, and thoracic duct; (4) the vagus, phrenic, left recurrent laryngeal, and cardiac nerves; (5) the thymus gland. The relative positions of these structures can be studied, in the meantime, in Figs. 38 and 40; afterwards they will be displayed in the course of dissection.

Middle Mediastinum.—This is the wide middle part of the space which contains the pericardium, and lies below the superior mediastinum. In addition to the pericardium and its contents, the middle mediastinum contains the phrenic nerves and their arteriæ comites.

Anterior Mediastinum.—The anterior mediastinum is that portion of the inter-pleural space which lies between the pericardium behind and the body of the sternum in front. It has already been examined (p. 12).

Posterior Mediastinum.—This is situated between the pericardium and the bodies of the vertebræ. It will be studied later on.

Dissection.—The central portion of the sternum, with the attached costal cartilages, may now be removed and laid aside until a suitable opportunity arises for the study of the chondro-sternal joints. Carefully strip the mediastinal pleura from the side of the pericardium. This will bring into view the *phrenic nerve* and the slender *arteria comes nervi phrenici*, a branch of the internal mammary artery which accompanies the phrenic nerve upon the side of the pericardial sac. During this dissection the minute *mediastinal* and *thymic branches* of the internal mammary artery will be brought into view.

Lungs (pulmones).—The lungs are two soft, spongy organs placed one on either side of the mediastinal space. When the thorax is opened (unless they have been hardened *in situ*) they collapse to about one-third of their original bulk, and it is difficult for the student to realise their proper dimensions and shape.

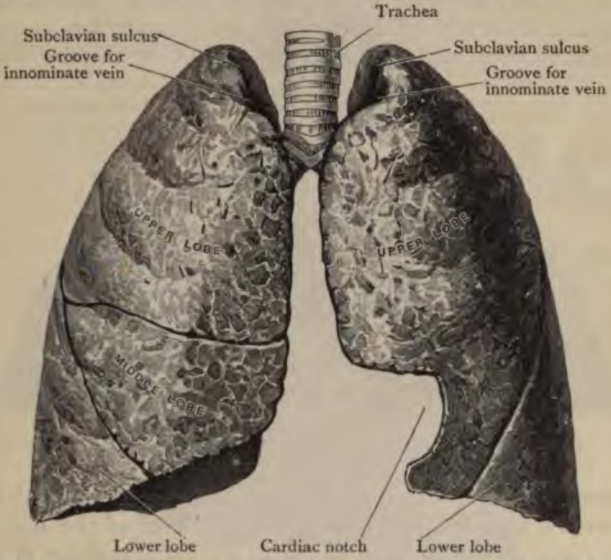
Trachea
Subclavian sulcus
Groove for innominate vein
Subclavian sulcus
Groove for innominate vein
UPPER LOBE
UPPER LOBE
MIDDLE LOBE
Lower lobe
Cardiac notch
Lower lobe

FIG. 13.—The Trachea, Bronchi, and Lungs of a Child, hardened by formalin injection.

In the event of the lungs not having been hardened *in situ* by formalin injection, the dissector of the thorax may (*with the consent* of the dissector of the head and neck) introduce the nozzle of the bellows into the cervical part of the trachea so as to inflate the lungs with air. A truer conception of these organs will thus be obtained, and a demonstration will be afforded of their high elasticity, and of their connection with the windpipe.

When healthy and sound, the lungs lie free within the cavity of the chest, and are only attached by their roots and by their ligamenta lata. It is rare, however, that a healthy lung is seen in the dissecting-room. Adhesions between the visceral and parietal portions of the pleura due to pleurisy are generally present. Each lung is accurately adapted to the space in which it lies, and, in the natural state, it bears on its surface impressions and elevations which are an exact counterpart of the inequalities of the parts with which its surfaces are in contact.

In its natural condition, before the chest is opened, each lung is conical in form, and presents for examination an apex, a base, an outer and an inner surface, and an anterior and a posterior border. The *apex of the lung* (apex pulmonis) is blunt and rounded, and rises above the level of the oblique first costal arch to the full height of the cervical dome of the pleura. It therefore protrudes upwards into the root of the neck. The subclavian artery arches outwards on its inner and anterior aspects a short distance below its summit, and a groove (sulcus subclavius) corresponding to the vessel is apparent upon it. At a lower level on the apex pulmonis a shallower and wider groove upon its inner and anterior aspects marks the position of the innominate and subclavian veins. Although these vessels impress the lung, they are separated from it by the cervical pleura. The *base of the lung* (basis pulmonis) presents a semilunar outline, and is adapted to the upper surface of the diaphragm. Consequently, it is deeply hollowed out; and as the right cupola of the diaphragm

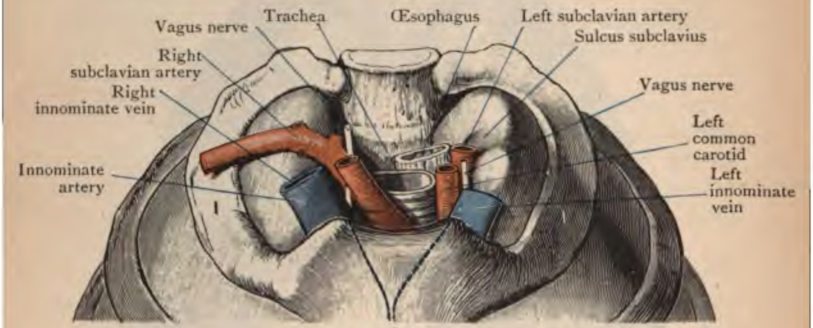
Vagus nerve
Trachea
Œsophagus
Left subclavian artery
Sulcus subclavius
Right subclavian artery
Right innominate vein
Vagus nerve
Left common carotid
Innominate artery
Left innominate vein
I

FIG. 14.—Cervical Domes of the Pleural Sacs, and parts in relation to them.

ascends higher than the left, the basal concavity of the right lung is deeper than that of the left lung. Laterally, and behind, the base of each lung is limited by a thin sharp margin, which passes downwards in the narrow pleural recess (*sinus phrenico-costalis*) between the diaphragm and chest wall. This margin extends much lower down behind and at the outer side than in front, but it falls considerably short of the bottom of the phrenico-costal sinus of pleura.

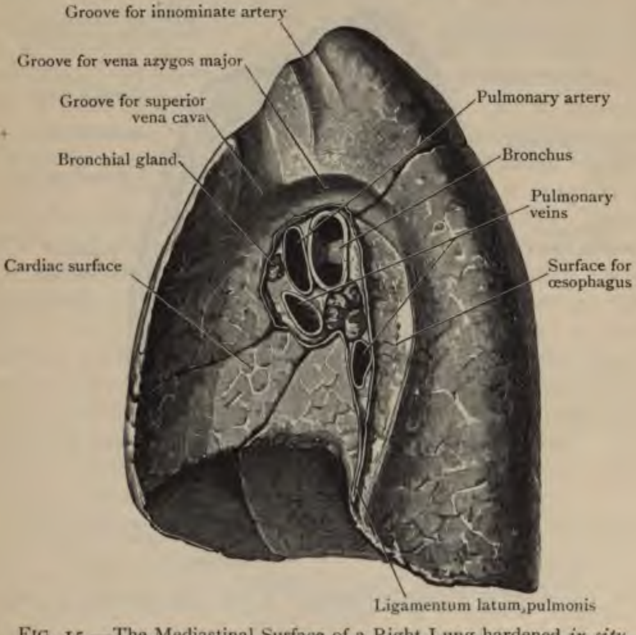
Groove for innominate artery
Groove for vena azygos major
Groove for superior vena cava
Bronchial gland
Cardiac surface
Pulmonary artery
Bronchus
Pulmonary veins
Surface for œsophagus
Ligamentum latum pulmonis

FIG. 15.—The Mediastinal Surface of a Right Lung hardened *in situ.*

The bases of the lungs establish important relations with the viscera, which occupy the costal zone of the abdominal cavity—the diaphragm alone intervening. Thus the base of the right lung rests upon the right lobe of the liver; whilst the base of the left lung is in relation to the left lobe of the liver, the stomach, the spleen, and in some cases to the splenic flexure of the colon.

The *outer surface of the lung* (facies costalis pulmonis) is very extensive and is full and convex. It is in relation to the parietal pleura, as it clothes the ribs and intercostal muscles, and it bears the impress of the costal arches. The inner or *mediastinal surface* (facies mediastinalis pulmonis) presents a smaller area than the outer surface. It is applied to the mediastinal partition, and presents markings which are the exact counterpart of the inequalities upon this septum. Thus it is deeply hollowed out in adaptation to the pericardium upon which it fits. This pericardial concavity comprises the greater part of the mediastinal surface, and, owing to the greater projection of the heart to the left side, it is much deeper and more extensive in the left lung than in the right lung. Above and behind the pericardial hollow is the *hilum* of the lung. This is a wedge-shaped depressed area, within which the vessels, nerves, lymphatics, together with the bronchus, enter and leave the organ. The hilum is surrounded by the reflection of the pleura from the surface of the lung on to the pulmonary root. Behind the hilum and the pericardial area there is a narrow strip of the inner surface of the lung which is in relation to the lateral wall of the posterior mediastinum. On the *right lung* this part of the surface is

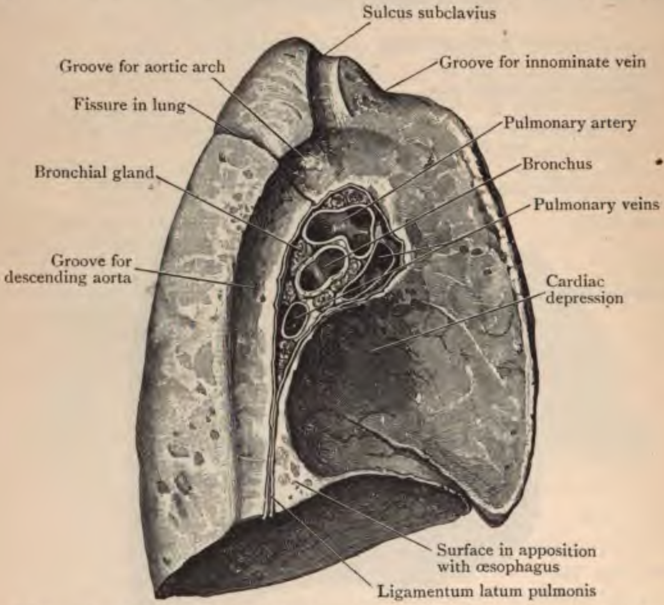
Sulcus subclavius
Groove for aortic arch
Groove for innominate vein
Fissure in lung
Pulmonary artery
Bronchus
Bronchial gland
Pulmonary veins
Groove for descending aorta
Cardiac depression
Surface in apposition with œsophagus
Ligamentum latum pulmonis

FIG. 16.—Inner or Mediastinal Aspect of a Left Lung hardened *in situ*.

depressed and corresponds to the œsophagus; on the *left lung* it presents a broad longitudinal groove which is produced by the contact of the lung with the descending thoracic aorta, and also, close to the base, a small triangular flattened area in front of this which is applied to the œsophagus where it pierces the diaphragm.

The portion of the inner surface of the lung which lies above the hilum and pericardial hollow is applied to the lateral aspect of the superior mediastinum, and the markings are accordingly different on the two sides. On the *left lung* a broad deep groove produced by the aortic arch curves over the hilum and becomes continuous with the aortic groove on the posterior mediastinal surface. From this a narrower, deeper, and much more sharply cut groove ascends and turns outwards over the apex pulmonis a short distance from the summit. This is the sulcus subclavius, and it contains the left subclavian artery when the lung is in its place. In front of this a shallow wide groove, also leading up to the front of the apex, corresponds to the left innominate vein. In the *right lung* the hilum is circumscribed above by a narrow curved groove which lodges the vena azygos major as it turns forward to join the superior vena cava. From the anterior end of the azygos sulcus a wide shallow groove leads upwards to the lower part of the apex pulmonis. This is produced by the vena cava superior and the right innominate vein. Close to the summit of the apex there is also, on its inner aspect, a sulcus for the upper part of the innominate artery.

The two borders of the lung offer a marked contrast to each other. The *anterior border* is short, thin, and sharp, and extends forwards and inwards in front of the pericardium into the narrow pleural recess behind the sternum and costal cartilages (*sinus costo-mediastinalis*). It begins abruptly above, immediately below the groove on the apex for the innominate vein, and extends down to the base, where it becomes continuous with the sharp basal border. The *posterior border of the lung* is thick, long, and rounded. It forms the most bulky part of the organ, and occupies the deep hollow of the thoracic cavity which is placed on each side of the spine.

Differences between the two Lungs.—There are some points, besides those already mentioned, in which the two lungs differ from each other:—(1) The right lung is slightly larger than the left, in the proportion of 11 to 10. (2) The right lung is shorter and wider than the left lung. This difference is due to the great bulk of the right lobe of the liver, which elevates the right cupola of the diaphragm to a higher level than the left cupola, and likewise to the heart and pericardium, projecting more to the left than the right, and thus diminishing the width of the left lung. (3) The anterior sharp margin of the right lung is more or less straight; the corresponding margin of the left lung presents, in its lower part, a marked angular deficiency (*incisura cardiaca*) for the reception of the apex of the heart and the pericardium. (4) The right lung is subdivided into three lobes, and the left lung into two.

Lobes of the Lungs.—The *left lung* is divided into two lobes by a long oblique deep fissure which penetrates its substance to within a short distance of the hilum. This fissure begins above at the posterior border, about two and a half inches below the apex, and about the level of the vertebral end of the third rib, and is continued on the outer surface in a somewhat spiral direction downwards and forwards to the anterior end of the base of the lung. The *upper lobe* of the lung (lobus superior) lies above and in front of this cleft. It is conical in form with an oblique base. The apex and the whole of the anterior border belong to it. The *lower lobe* (lobus inferior), somewhat quadrangular, lies below and behind the fissure, and belonging to it we recognise the entire base and the greater part of the thick posterior border. It is therefore the more bulky of the two.

In the *right lung* there are two fissures subdividing it into three lobes. One of these fissures is very similar in its position and relations to the fissure in the left lung. It is, however, more vertical in its direction, and ends below somewhat farther outwards. It separates the lower lobe from the upper and middle lobes. The second cleft begins in the main fissure at the posterior border of the lung, and proceeds horizontally forwards on the outer surface to end at the anterior border of the lung at the level of the fourth costal cartilage. The middle or intermediate lobe is wedge-shaped in outline.

Root of the Lung (radix pulmonis).—This is the term which is applied to a number of structures which enter the lung at the hilum or slit upon its inner mediastinal surface. These structures are held together by an investment of pleura, and constitute a pedicle which attaches the lung to the mediastinal wall of the pleural cavity.

The pleura should be carefully stripped from around the root of the lung; but, before undertaking the dissection of the structures which compose the root, the relation which it bears to neighbouring parts should be determined.

In front there are—(1) a delicate plexus of nerves, the anterior pulmonary plexus; and (2) the phrenic nerve with the arteria comes nervi phrenici. *Behind*, the pneumogastric nerve breaks up into the posterior pulmonary plexus; whilst *inferiorly*, there is the ligamentum latum pulmonis. These are the relations which are common to the root of the lung upon both sides of the body, but there are others which are peculiar to each side.

On the *right side*—(1) The vena azygos major, as it curves forwards over the right bronchus to join the superior vena cava, is in relation to the upper border of the pulmonary root; (2) the superior vena cava, in the lower part of its course, lies in front of the pulmonary root.

On the *left side*, the aorta arches over the root of the lung, and the descending thoracic aorta passes down behind it.

Dissection.—Now proceed to dissect out the constituent parts of the root of the lung.

Constituent parts of the Pulmonary Root.—The most important structures which enter into the formation of the pulmonary root are—(1) the *two pulmonary veins*; (2) the *pulmonary artery*; (3) the *bronchus*. But, in addition to these, there are one or more small *bronchial arteries* and *veins*, the *pulmonary nerves*, the *pulmonary lymphatic vessels*, and some *bronchial glands*. These are bound together by some loose areolar tissue, and the whole pedicle so constituted is invested by pleura.

The *pulmonary nerves* are derived from the anterior and posterior pulmonary plexuses. The *anterior pulmonary plexus* is composed of two or three delicate filaments, which come from the pneumogastric nerve before it reaches the posterior aspect of the pulmonary root. These join with the sympathetic twigs on the wall of the pulmonary artery. The deep cardiac plexus gives twigs to the anterior pulmonary plexus on both sides of the body, and the plexus of the left side likewise receives a few filaments from the superficial cardiac plexus. It is only under the most favourable circumstances that a good view of these nerves can be obtained.

Dissection.—The *posterior pulmonary plexus* is easily dissected. To get at it, the lung must be thrown well forwards over the pericardium, and the pleura stripped from the posterior surface of the pulmonary root. The pneumogastric nerve should then be secured and followed downwards. On the left side it will be found crossing the aortic arch; on the right side it lies by the side of the trachea.

The *posterior pulmonary plexus* is formed by the entire trunk of the pneumogastric nerve breaking up into a flattened network immediately under cover of the pleura upon the posterior aspect of the root of the lung. Several minute twigs from the upper thoracic ganglia of the sympathetic enter this plexus. The posterior pulmonary plexuses of opposite sides are connected by some strong branches, which cross the mesial plane in front of and behind the œsophagus. From both the anterior and posterior pulmonary plexuses fine twigs are prolonged into the lung along the divisions of the bronchi. The posterior branches, however, are much larger than the anterior.

The *bronchial arteries* (arteriæ bronchiales), one to three in number on each side, are the proper nutrient vessels of the lung. They are placed on the posterior aspect of the root of the lung, and have, no doubt, been exposed in the dissection of the posterior pulmonary plexus. As a general rule they lie in close contact with the back of the corresponding bronchus and follow it into the lung.

Part of the blood conveyed to the lungs by the bronchial arteries is returned by the pulmonary veins; the remainder is returned by special *bronchial veins*, which open on the right side into the vena azygos major, and on the left side into the vena azygos minor superior.

Dissection.—The *pulmonary vessels* and the *bronchus* should now be separated from each other with the handle of the knife, and their relative positions in the root of the lung studied. This dissection should be made, not only in front, but also behind, so that the parts may be thoroughly isolated and rendered distinct. Hardened and blackened bronchial glands sometimes make the dissection a difficult one. These must be removed.

The *bronchus* lies in the posterior part of the root of the lung behind both the pulmonary artery and the higher of the two pulmonary veins. The *pulmonary artery* holds an intermediate position, whilst the *higher* of the two *pulmonary veins* is placed in front of the artery. When examined in respect to their relations from above downwards, the right and left pulmonary roots are seen to differ from each other. On both sides the *veins* occupy the lowest level—the lower vein being situated in the very lowest part of the hilum of the lung. On the *right side* the bronchus is highest and the artery intermediate, whereas on the *left side* the artery is highest and the bronchus intermediate in position. The different position of the bronchus in the roots of the lungs is due to the fact that on the right side a branch which is topographically not represented on the left side arises from the bronchus a short distance from its origin, and proceeds almost horizontally outwards to the upper lobe of the lung. This division lies above the level of the pulmonary artery, and in consequence receives the name of the *eparterial bronchus*. The other branches of the right bronchus, and all the branches of the left bronchus, lie below the level of the main trunk of the corresponding pulmonary artery, and are termed *hyparterial bronchi*.

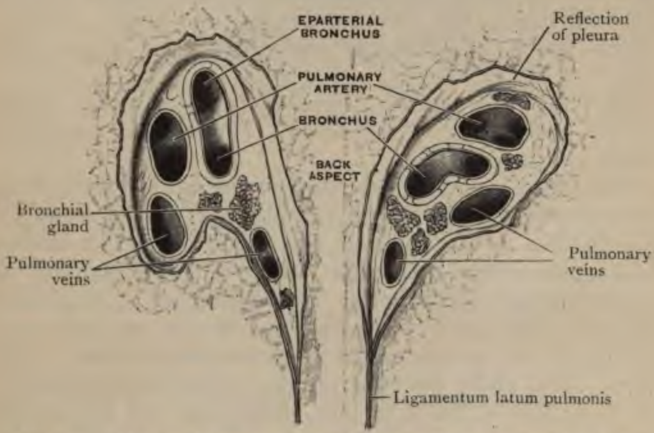
EPARTERIAL BRONCHUS
Reflection of pleura
PULMONARY ARTERY
BRONCHUS
BACK ASPECT
Bronchial gland
Pulmonary veins
Pulmonary veins
Ligamentum latum pulmonis

FIG. 17.—The two Pulmonary Roots transversely divided close to the hilum of each lung.

Phrenic Nerve (nervus phrenicus).—This is a long nerve which arises in the neck from the cervical plexus, and traverses the entire length of the mediastinal space to reach the diaphragm. It has already been exposed upon the lateral aspect of the pericardium in front of the root of the lung. Follow it upwards and downwards.

The phrenic nerve enters the chest cavity through the thoracic inlet, and as it does so it passes behind the subclavian vein, and crosses obliquely the internal mammary artery in a direction from without inwards. It now proceeds downwards through the superior mediastinum into the middle mediastinum. In the latter it is applied to the side of the pericardium in front of the root of the lung, and is covered by the mediastinal pleura. Finally reaching the diaphragm, the nerve breaks up into several branches which pierce its substance and spread out on its under surface.

But the two phrenic nerves of opposite sides present certain differences. They differ (1) in length; and (2) in certain of their relations.

The left phrenic is the longer of the two nerves, and this is due partly to the greater projection of the heart and pericardium to the left side, and partly to the fact that the left cupola of the diaphragm which it enters does not rise so high as the right cupola. The differences in relationship are the following:—(1) As they traverse the superior mediastinum the left phrenic nerve crosses the vagus nerve and the aortic arch, whilst the right phrenic nerve lies in relation to the right side of the right innominate vein and the superior vena cava; (2) one or more of the terminal branches of the right nerve pass through the opening in the diaphragm for the inferior vena cava.

The *branches* of the phrenic are chiefly destined for the supply of the diaphragm, but in its course through the middle mediastinum it gives a few fine filaments to the pericardium and the pleura.

The small branch of the internal mammary artery which accompanies the phrenic nerve, the *arteria comes nervi phrenici*, may be traced in a well-injected subject to the fore-part of the diaphragm. It takes origin high up in the thorax, and gives branches to the pericardium.

Superficial Cardiac Plexus.—The best plan to adopt in making a dissection of these delicate nerve filaments is to begin by securing the two cardiac nerves which enter the plexus from above. These are—(1) the cardiac branch from the superior cervical ganglion of the sympathetic of the *left* side; (2) the inferior cervical cardiac branch of the *left* pneumogastric nerve. Look for both of these nerves upon the aortic arch. They will be found crossing it to the left of the phrenic nerve, between it and the pneumogastric nerve. The cardiac branch from the left pneumogastric nerve is the smaller of the two, and as a general rule it lies nearer the phrenic nerve than the other.

The superficial cardiac plexus into which these nerves may be traced lies in the concavity of the aortic arch, and upon the bifurcation of the pulmonary artery. At the point of junction of the nerves the minute *ganglion of Wrisberg* may be discovered. The manner in which this plexus is distributed to the heart will be afterwards noted: in the meantime, observe that it gives some fine offsets to the left anterior pulmonary plexus.

Dissection.—The pericardium should now be cleaned. In removing the loose areolar tissue from its anterior surface two ligamentous bands which connect it to the posterior aspect of the sternum will be observed. Of these, one—the *inferior sterno-pericardiac ligament*—binds it to the ensiform cartilage, whilst the other—the *superior sterno-pericardiac ligament*—connects it with the manubrium sterni, and comes into relation with the pretracheal layer of the deep cervical fascia. The upper surface of the diaphragm should be carefully cleaned at the same time, in order that its relation to the pericardium may be studied.

Pericardium.—The pericardium is a fibro-serous sac which loosely envelops the heart. It is placed in the middle subdivision of the mediastinal space, and presents a somewhat conical form. By its *base* it rests chiefly upon the central tendinous part of the diaphragm, but beyond the limits of this it encroaches, to some extent, upon the muscular portion. More especially is this the case on the left side. Except at one point, no difficulty will be experienced in separating the pericardium from the diaphragm. The two are simply bound together by some intervening areolar tissue. Towards the middle line, however, it will be found over a small area to be inseparably blended with the central tendon. It is important to recognise the abdominal viscera which stand in relation to the base of the pericardium. It is placed, for the greater part of its extent, over the upper surface of the liver, the diaphragm alone intervening; but in front, a small part corresponding to the apex of the heart projects beyond the area of the liver and comes to lie over the stomach. The upper *narrow part* of the pericardium will be noticed to close upon certain of the great vessels that issue from the base of the heart. *Upon each side* the pericardium is adapted to the concave part of the mediastinal surface of the lung. It is clothed by the mediastinal pleura, and has in relation to it the phrenic nerve and the arteria comes nervi phrenici. *In front*, very important relations have to be studied. It lies behind the sternum and costal cartilages, and is for the most part separated from these by the two pleural sacs, and by the anterior thin margins of the lungs. Below the level of the sternal end of the fourth costal cartilage, however, owing to

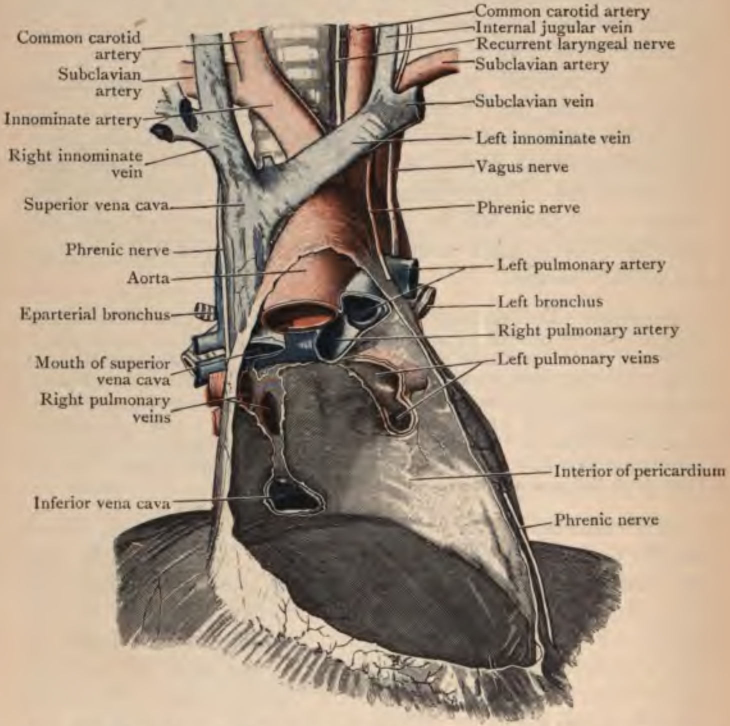
Common carotid artery
Subclavian artery
Innominate artery
Right innominate vein
Superior vena cava
Phrenic nerve
Aorta
Eparterial bronchus
Mouth of superior vena cava
Right pulmonary veins
Inferior vena cava
Common carotid artery
Internal jugular vein
Recurrent laryngeal nerve
Subclavian artery
Subclavian vein
Left innominate vein
Vagus nerve
Phrenic nerve
Left pulmonary artery
Left bronchus
Right pulmonary artery
Left pulmonary veins
Interior of pericardium
Phrenic nerve

FIG. 18.—The Pericardium and Great Vessels of the Heart. The thoracic organs were hardened *in situ* by formalin injection. The pericardium having been opened by the removal of its anterior wall, the great vessels were divided and the heart removed.

the left pleura retreating somewhat to the left, a small area of the anterior surface of the pericardium, as a general rule, comes into direct relation with the chest wall. The extent[1] of this area, as we have already seen, is variable. *Behind*, the pericardium forms the anterior wall of the posterior mediastinum, and is in relation to the contents of this space. Its relation to the œsophagus is especially intimate.

Fibrous Pericardium.—When the pericardium is denuded of the loose areolar tissue which surrounds it and binds it to adjacent structures, the strong dense character of the fibrous membrane which forms its *outer layer* will be seen. This fibrous layer is pierced by the various vessels which pass to and from the heart, and is prolonged upon the walls of these vessels in the form of tubular investments which gradually become lost upon their coats. The only vessel which fails to receive such a prolongation is the inferior vena cava, and this is due to the fact that this vein pierces the pericardium where it rests on the diaphragm, and can, therefore, hardly be said to have any intra-thoracic course outside the pericardium.

The entire length of the pulmonary artery and of the ascending aorta are enclosed within the fibrous sac of the pericardium. Portions also of the superior vena cava and the four pulmonary veins are contained within the fibrous pericardium.

Dissection.—The pericardium may be opened by means of a crucial incision, viz.—(1) a longitudinal incision along the middle line of the body from the point where it blends with the sheath of the aorta downwards to the diaphragm; (2) a transverse cut, extending from the middle of the root of one lung to a similar point on the opposite side.

Serous Layer of the Pericardium.—The internal serous layer is now exposed. This layer, which forms a completely closed sac, lines the entire inner surface of the fibrous pericardium, and is reflected from this, upon the vessels which pierce the fibrous layer, on to the surface of the heart. It gives a smooth, polished appearance to the heart and to the interior of the pericardial sac. The lining part of the serous layer is termed the *parietal portion;* the investing portion which covers the heart is called the *visceral part* or *the epi-*

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[1] The importance of recognising this bare area of the pericardium will be understood when it is remembered that it is here that the surgeon taps the cavity of the sac when it is distended with fluid.

cardium. The great vessels in connection with the heart, as they lie within the fibrous pericardium, also receive more or less complete coverings from the serous layer. The two arteries, viz., the pulmonary artery and the aorta, are completely surrounded by a single tubular sheath which is common to both. This investment only leaves uncovered the surfaces of these vessels which are in apposition with each other—a fact which can readily be demonstrated by passing the forefinger behind them. The term *sinus transversus pericardii* is given to the passage through which the finger goes. It intervenes between the two arteries in front, and the auricular part of the heart behind.

In the case of the veins, the covering which they receive from the serous pericardium is not so complete. They are covered in front and on each side, whilst posteriorly they are bare and in contact with the fibrous layer of the sac. The superior vena cava, which lies immediately to the right of the ascending part of the aorta, is a good example of this. The lower half of this vein is enclosed within the fibrous sac, but only two-thirds of its circumference has a serous covering. The inferior vena cava, which pierces the base of the pericardium, and at once opens into the right auricle of the heart, receives a very small investment.

When the apex of the heart is drawn forwards and upwards, a deep, blind recess of the serous pericardium will be seen, passing upwards behind it, between the openings of the pulmonary veins of opposite sides into the back of the left auricle. This recess lies between the posterior or auricular surface of the heart and the posterior wall of the fibrous pericardium, and is called the *oblique sinus.*

Lastly, separate the left pulmonary artery from the upper of the two left pulmonary veins, as they lie within the fibrous pericardium. Stretching across the interval between them will be seen a prominent semilunar fold of the serous pericardium. This is the "*vestigial fold of Marshall.*" It contains between its two layers a minute fibrous band (ligamentum cavæ sinistræ), the remnant of the left superior vena cava of the embryo.

Remains of the Thymus.—The *thymus gland*, which is a large and conspicuous object in the superior and middle portions of the mediastinum of the fœtus and young child, is only represented in the adult by two slender elongated bodies placed in the fore part of the superior mediastinum in front of the aortic arch and the left innominate vein. A few *thymic branches* from the internal mammary artery enter the wasted remains of the gland, and some small veins pass from it and join the subjacent left innominate venous trunk.

Dissection.—Remove the thymus, and dissect out the two innominate veins and the superior vena cava. The left innominate vein will be seen crossing the superior mediastinum from left to right. The short right innominate vein is placed in the upper and right part of the superior mediastinum. The union of these two trunks forms the vena cava superior. The tributaries which enter these veins must also be secured. One, the left superior intercostal vein, ascends upon the aortic arch to reach the left innominate.

Innominate Veins.—The *innominate vein* of each side is formed behind the sternal end of the clavicle by the union of the subclavian and internal jugular veins. Behind the lower part of the junction of the first costal cartilage of the right side with the sternum, they unite to form the superior vena cava.

The *right innominate vein* (vena anonyma dextra) is short. It is not more than one inch in length, and it has a nearly vertical course from above downwards. It is covered on its outer and anterior aspects by the right mediastinal pleura, and the phrenic nerve is applied to its outer side. The upper part of the innominate artery lies to its inner or left side.

The *left innominate vein* (vena anonyma sinistra) is much longer than the right vein, and has an oblique course from the left downwards and to the right. It is placed behind the manubrium sterni and the remains of the thymus gland, and crosses in front of the three great arteries which spring from the aortic arch and also in front of the left vagus and left phrenic nerves. In the greater part of its extent it is covered by the left mediastinal pleura.

The innominate vein of each side receives the following tributaries:—

1. The vertebral vein.
2. The inferior thyroid vein.
3. The vein which drains the blood from the first or highest intercostal space.
4. The internal mammary vein.

The left innominate vein in addition receives the left superior intercostal vein, and some small venous twigs from the thymus gland. The *left superior intercostal vein* is formed by the union of the veins from the second and third intercostal spaces. It crosses the arch of the aorta, and is of interest in so far that its upper part represents the upper pervious portion of the occluded left superior vena cava of the embryo.

Vena Cava Superior.—This great vein is formed behind the first costo-sternal junction of the right side by the union of the two innominate veins. From this it proceeds downwards, and it opens into the upper and back part of the right auricle of the heart at the level of the upper border of the third costal cartilage of the right side. It is three inches long, and shows very different relations in its upper and lower parts. In the *upper half* of its course it lies in the superior mediastinum (Fig. 38, p. 68). On the right side it is clothed by the mediastinal pleura, and has the phrenic nerve in contact with it; on the left side it is in relation to the innominate artery. In the *lower half* of its course it is enclosed within the fibrous pericardium, and is placed in the middle mediastinum. The serous pericardium covers it in front and laterally, whilst immediately to its left side is the ascending aorta. This portion of the superior vena cava lies in front of the right bronchus, the right pulmonary artery, and the upper right pulmonary vein (Fig. 39, p. 69).

The *vena azygos major* is the only large tributary which joins the superior vena cava. It comes forwards above the right bronchus, and enters the vena cava immediately above the point where it pierces the pericardium. Minute *pericardiac* and *mediastinal veins* also pour their blood into it.

Inferior Vena Cava.—This is a larger vessel than the superior vein of the same name. It enters the thorax by piercing the central tendon of the diaphragm. It can hardly be said to have any course within the thorax, seeing that it immediately passes through the base of the pericardium, and opens into the lower and back part of the right auricle of the heart.

Heart.—The heart is a hollow organ with muscular walls and somewhat conical in shape. It is placed obliquely within the middle mediastinum, so that its basal portion (basis cordis) is directed backwards, and slightly to the right, while its pointed apex looks downwards, forwards, and to the left. But it is also placed unsymmetrically within the chest cavity. In other words, it projects more to the left than to the right; and in cases where the frozen body is divided accurately in the mesial plane, it is found that about one-third of the organ is in the right, and about two-thirds in the left half of the thoracic cavity (Fig. 19).

General Relations of the Heart.—The *base* or *posterior surface* of the heart is placed in front of the middle portion of the dorsal segment of the vertebral column. Four dorsal vertebræ lie above it, and four below it, whilst the intermediate four (viz., the 5th, 6th, 7th, and 8th) lie behind it. The *apex* approaches the anterior wall of the thorax, and in life will be felt beating in the fifth intercostal space of the left side, one and a half inches below the nipple, and three and a half inches from the middle line. The *inferior surface* (facies diaphragmatica), which is flattened, and looks downwards, rests upon the diaphragm—the floor of the pericardium alone intervening. Immediately below the cardiac area of the diaphragm is the upper surface of the liver, and in front and to the left a small piece of the stomach. The *antero-superior surface* (facies sternalis) of the heart looks upwards as well as forwards, and lies behind the greater part of the gladiolus of the sternum and the third, fourth, fifth, and sixth cartilages of both sides. Owing to the greater projection of the organ to the left, only a small portion of the inner ends of these cartilages lies in front of the heart on the right side. A much larger area of the antero-superior cardiac surface lies behind the left costal cartilages. Indeed, behind the fourth and fifth costal cartilages the left margin of the heart approaches closely to the junction between the osseous and cartilaginous portions of these costal arches. The pleural sacs and the anterior thin margins of the lungs intervene between the heart enclosed within the pericardium and the anterior wall of the thorax. A small portion of the pericardium in the lower part of the anterior mediastinum is in direct relation to the triangularis sterni muscle as it covers the

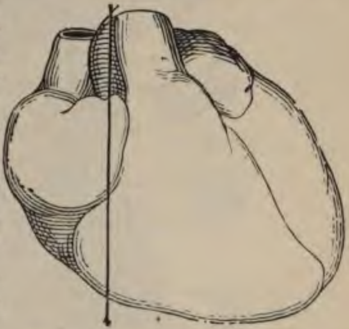

FIG. 19.—The vertical line drawn through the heart represents the mesial plane. (From Braune.)

deep surface of the sternum, and the inner extremities of the fifth and sixth costal cartilages of the left side. A wider area at the same level, owing to the incisura cardiaca in the anterior margin of the left lung, is uncovered by the lung (Fig. 8, p. 18). This area may be mapped out on the chest wall by drawing a vertical line along the middle line of the sternum, from the level of the inner extremities of the fourth costal cartilages to the lower end of the gladiolus, and by carrying two other lines, from its extremities, outwards so as to meet at a point over the apex beat of the heart. *On either side*, the heart

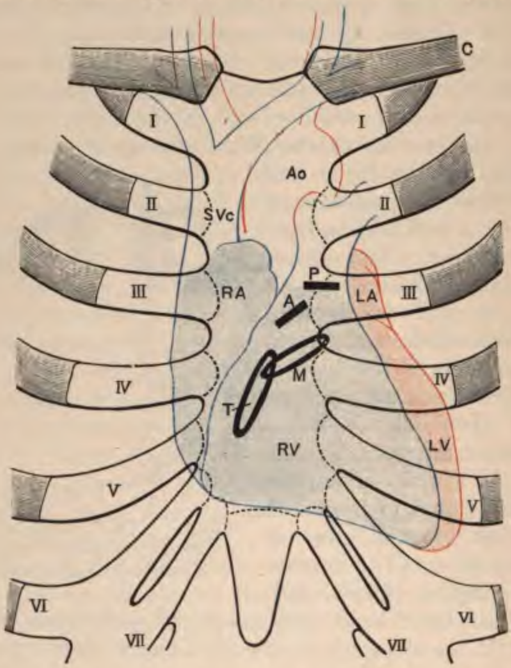

FIG. 20.—The relations of the Heart and of its Orifices to the Anterior Thoracic Wall. (Young and Robinson.)

I to VII.	Costal cartilages.	M.	Mitral orifice.
A.	Aortic orifice.	P.	Pulmonary orifice.
Ao.	Aorta.	RA.	Right auricle.
C.	Clavicle.	RV.	Right ventricle.
LA.	Left auricle.	SVc.	Superior vena cava.
LV.	Left ventricle.	T.	Tricuspid orifice.

and pericardium is supported by the mediastinal pleura and the inner surface of the lung.

The heart lies free within the sac formed by the pericardium, except where it is attached by the great vessels which are connected with its basal portion. Its position is influenced, to a certain extent, by the position of the body.

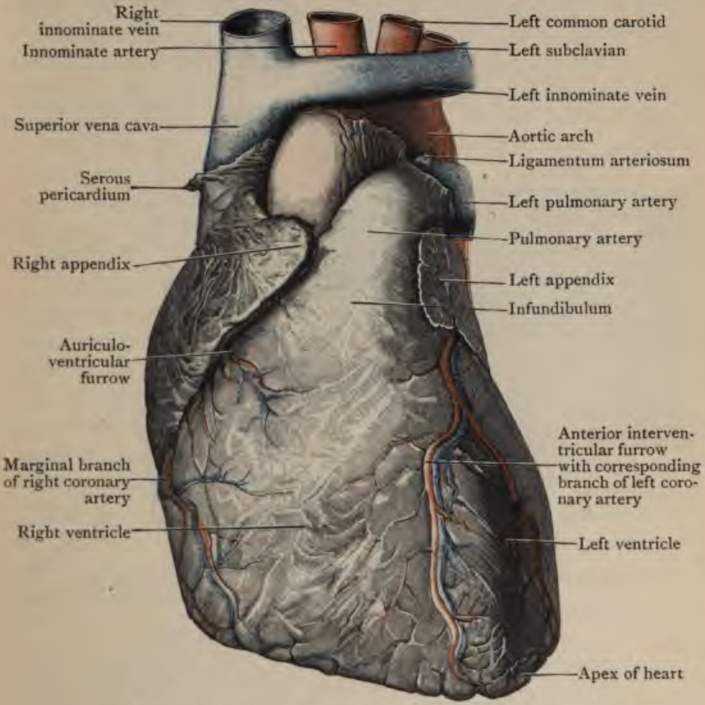
Right innominate vein
Innominate artery
Superior vena cava
Serous pericardium
Right appendix
Auriculo-ventricular furrow
Marginal branch of right coronary artery
Right ventricle
Left common carotid
Left subclavian
Left innominate vein
Aortic arch
Ligamentum arteriosum
Left pulmonary artery
Pulmonary artery
Left appendix
Infundibulum
Anterior interventricular furrow with corresponding branch of left coronary artery
Left ventricle
Apex of heart

FIG. 21.—Anterior or Sternal Aspect of the Heart.

External Configuration of the Heart.—In studying the form and appearance of the heart, the dissector will find it advantageous to refer to a specimen which has been hardened *in situ* by formalin injection.

The interior of the heart is divided by an internal, obliquely placed partition into a right and a left cavity. Further, each of these is still further subdivided into an upper *auricular* and a lower *ventricular chamber*, which communicate freely with each other through a wide *auriculo-ventricular opening.* The right and the left cavities of the heart, however, are completely shut off from each other.

On the exterior of the heart there are markings which indicate this internal subdivision, and enable us to map out with the greatest accuracy the walls of the four chambers. Thus encircling the heart nearer the base than the apex, and in a direction transverse to its long axis, is a deep furrow which is continuous all the way round, except in front, where it is interrupted by the root of the pulmonary artery. This is the *auriculo-ventricular groove* (sulcus coronarius). It intervenes between the auricles which lie behind it and the ventricles which are placed in front and, to some extent, below it. In the undissected heart, with the epicardium in position, the depth of this furrow is greatly obscured, from

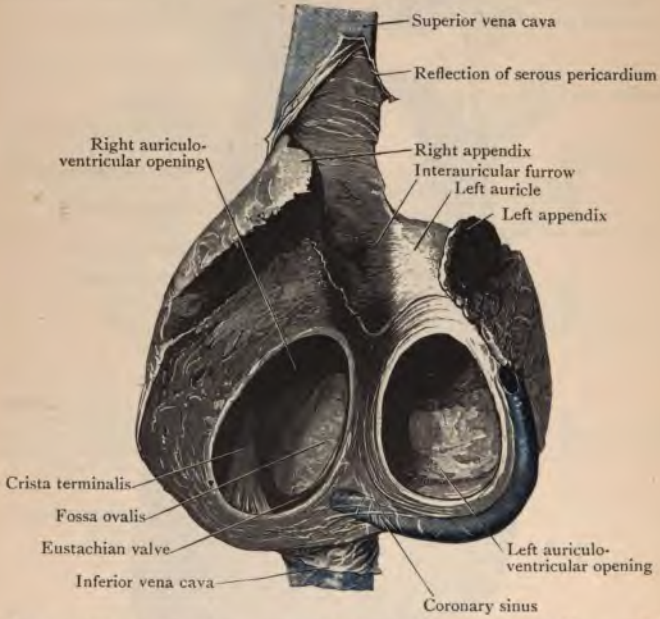
Superior vena cava
Reflection of serous pericardium
Right auriculo-ventricular opening
Right appendix
Interauricular furrow
Left auricle
Left appendix
Crista terminalis
Fossa ovalis
Eustachian valve
Inferior vena cava
Left auriculo-ventricular opening
Coronary sinus

FIG. 22.—The Anterior Aspect of the Auricular Part of the Heart. The auricles have been removed from the ventricles. The ventricular portion of the same heart is depicted in Fig. 25. The specimen was hardened *in situ.*

the fact that it lodges some large blood vessels and a certain amount of fat.

The **Auricular Part** of the heart stands in marked contrast with the firm ventricular portion. Its walls are thin and flaccid, and, in the heart which has not been hardened by formalin, they are collapsed, so that it is difficult to realise the shape of this portion of the organ. It is crescentic in form. The chief bulk of it is placed behind, but it sends upwards and forwards two processes or cornua, termed the *auricular appendices*. A deep concavity or hollow is thus produced, in which lie the two great arterial trunks which spring from the ventricles, viz., the pulmonary artery in front and the aorta behind. These great vessels are, as it were, clasped between the auricular appendices.

On referring to the hardened organ it will be seen that the whole of the posterior surface or base of the heart is formed by the auricles. The surface thus constituted is somewhat quadrangular in outline. Above, it is in intimate relation to the two pulmonary arteries as they run to the right and to the left to enter the pulmonary roots; below, it is limited by that part of the auriculo-ventricular groove which is occupied by the coronary sinus. A groove which runs downwards on the right auricle from the front of the opening of the superior vena cava to the right of the opening of the inferior vena cava may be taken as bounding the posterior auricular surface on the right. This furrow is termed the *sulcus terminalis*, and it has an interesting embryological significance. The entrance of the two left pulmonary veins into the left auricle form the left limit of the posterior auricular surface of the heart. By far the greater part of this posterior surface is formed by the left auricle, and the exact proportions which the two auricular chambers contribute to this surface are indicated on the hardened organ by a faint groove termed the *interauricular*

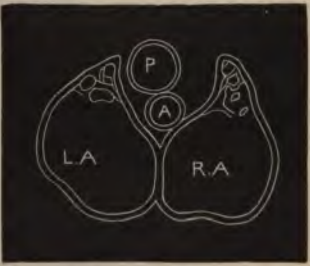

FIG. 23.—Transverse section through the Auricular Part of the Heart of an Ox.

R.A. Right auricle.
L.A. Left auricle.
P. Pulmonary artery.
A. Aorta.

furrow, which pursues a vertical course immediately to the left of the openings of the two venæ cavæ. This furrow indicates the posterior attachment of the interauricular septum.

Each auricle is composed of a roomy capacious posterior part into which the veins open and into which the blood flows, termed the *atrium*, and a more or less pointed projection which springs from the upper and fore part of the atrium. This prolongation is the *auricular appendix*.

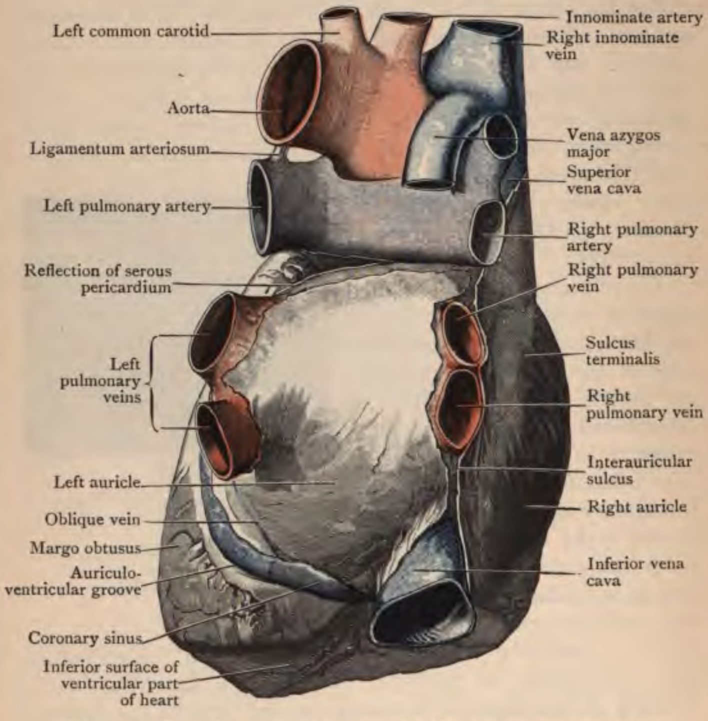
Left common carotid
Innominate artery
Right innominate vein
Aorta
Ligamentum arteriosum
Vena azygos major
Superior vena cava
Left pulmonary artery
Right pulmonary artery
Reflection of serous pericardium
Right pulmonary vein
Left pulmonary veins
Sulcus terminalis
Right pulmonary vein
Interauricular sulcus
Left auricle
Right auricle
Oblique vein
Margo obtusus
Auriculo-ventricular groove
Inferior vena cava
Coronary sinus
Inferior surface of ventricular part of heart

FIG. 24.—Posterior or Basal Aspect of a Heart hardened *in situ* by formalin injection.

The superior vena cava will be seen to open into the upper part of the atrium of the right auricle; the inferior vena cava opens into the lower part of the same atrium.

Between these two openings, and immediately to the left of the interauricular furrow, the two right pulmonary veins pierce the posterior wall of the atrium of the left auricle; the left pulmonary veins open into the same atrium at the left limit of the posterior surface of the heart.

The **Ventricular Part** of the heart is firm to the touch and possesses thick fleshy walls. It is conical in form. Its apex corresponds to the apex of the heart; whilst its base is connected behind with the two atria of the auricular part of the heart, and gives origin above and in front of these, and in the interval between the auricular appendices, to the two great arteries which conduct the blood from the ventricular chambers, viz., the pulmonary artery in front, and the aorta behind.

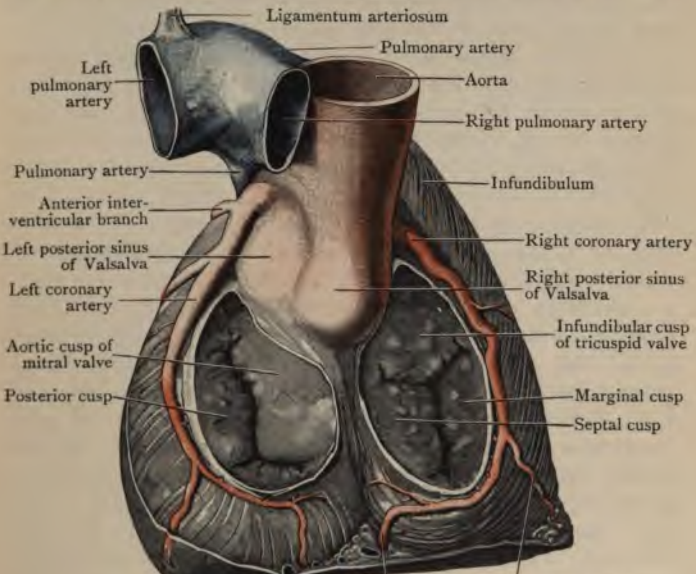
Ligamentum arteriosum
Pulmonary artery
Left pulmonary artery
Aorta
Right pulmonary artery
Pulmonary artery
Infundibulum
Anterior interventricular branch
Right coronary artery
Left posterior sinus of Valsalva
Right posterior sinus of Valsalva
Left coronary artery
Infundibular cusp of tricuspid valve
Aortic cusp of mitral valve
Posterior cusp
Marginal cusp
Septal cusp
Marginal branch
Inferior interventricular branch

FIG. 25.—The Base of the Ventricular Part of the Heart from which the Auricles have been removed. The detached auricles are depicted in Fig. 22. The specimen was hardened *in situ.*

In addition to the base and apex, the ventricular part of the heart presents two borders and two surfaces. One border is long and sharp, and runs from right to left, from the base to the apex. It occupies that part of the basal portion of the pericardium which lies in the narrow interval between the diaphragm and the anterior wall of the chest; it is called the *anterior border* or the *margo acutus*. The *left border* or *margo obtusus* is short, thick, and rounded.

The *antero-superior surface* (facies sternalis) of the ventricular part of the heart is full and convex, and is traversed by a groove which begins above at the auriculo-ventricular furrow immediately to the left of the origin of the pulmonary artery, and proceeds forwards and downwards towards the sharp margin, which it reaches a little to the right of the apex. This groove is the *anterior interventricular furrow* (sulcus longitudinalis anterior), and it is placed much nearer to the left margin than to the sharp anterior margin of the heart (Fig. 21, p. 43). The *inferior surface* (facies diaphragmatica) is flattened and traversed by a similar groove (Fig. 24, p. 46), the *inferior interventricular furrow* (sulcus longitudinalis posterior). This joins the anterior groove below, round the anterior sharp margin of the heart. These grooves are occupied by vessels and lodge a little fat. They indicate on the surface the attachments of the interventricular septum, and therefore the extent of the walls of the two cavities. Roughly speaking, two-thirds of the antero-superior surface, the margo acutus, and rather more than one-third of the inferior surface, belong to the right ventricle; whilst one-third of the antero-superior surface, the margo obtusus, the apex of the heart, and rather less than two-thirds of the inferior surface, belong to the left ventricle. On the antero-superior surface of the heart a bulging of the wall of the right ventricle will be noticed in its upper and front part. This is termed the *infundibulum* or *conus arteriosus* (Fig. 21, p. 43). From its summit the pulmonary artery takes origin.

Dissection.—The vessels and nerves which are distributed to the substance of the heart may now be dissected. The main trunks occupy the furrows, and can be exposed by removing the epicardium and the soft fat which is generally placed around them. In a young subject, where the fat is scanty and the vessels well injected, very little dissection is required. The nerves are exceedingly delicate and are derived from the cardiac plexus. It is seldom that they can be satisfactorily displayed in an ordinary dissecting-room subject.

Coronary Arteries (Fig. 25, p. 47).—These are the nutrient vessels of the heart. They are two in number, and spring from the root of the ascending aorta. It is here, therefore, that they must in the first instance be sought, by dissecting deeply in the auriculo-ventricular furrow. The *left coronary artery* (arteria coronaria sinistra) springs from the left posterior sinus of Valsalva,[1] and proceeds outwards behind the pulmonary artery. It winds round the left side of the left auriculo-ventricular opening (ramus circumflexus), and ends on the inferior aspect of the heart. Throughout its entire course it lies in the auriculo-ventricular furrow. It gives off numerous twigs to the left auricle and left ventricle, and one large branch will be observed to pass downwards in the anterior interventricular groove towards the apex of the heart (ramus descendens).

The *right coronary artery* (arteria coronaria dextra) arises from the anterior sinus of Valsalva, and winds round the right side of the right auriculo-ventricular opening in the auriculo-ventricular groove to reach the inferior aspect of the heart, where it ends near the termination of the artery of the left side. An arterial circle is thus formed, which embraces the heart in the auriculo-ventricular groove. The right coronary artery gives off two large branches. Of these, one passes towards the apex upon the sharp margin of the heart, whilst the second and larger proceeds towards the apex in the inferior interventricular groove (ramus descendens). It also supplies numerous smaller twigs to the right ventricle and right auricle.

Cardiac Veins (venæ cordis).—Take hold of the heart by the apex and pull it upwards, so as to bring into view its inferior surface. In the groove between the left ventricle and left auricle—the *coronary sinus* (sinus coronarius)—a short wide venous channel will be seen (Fig. 24, p. 46). Open it with the scissors along its whole length. By one extremity it opens into the right auricle, whilst by its other end it becomes continuous with the *great cardiac vein*, and the point of junction is marked by a valve of two segments. Several *posterior cardiac veins* from the inferior aspect of the ventricles also open into this

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[1] The three sinuses of Valsalva are three bulgings of the wall of the aortic root. One is on the front, and the other two on the back of the vessel.

LANE

sinus, and each orifice is guarded by a distinct valve. Of these, one much larger than the others, and called the *middle cardiac vein* (vena cordis media), occupies the inferior interventricular groove. The *right* or *small cardiac vein* (vena cordis parva) likewise joins the coronary sinus close to its termination. It occupies that part of the auriculo-ventricular furrow which, on the posterior surface of the heart, intervenes between the right auricle and right ventricle. Lastly, the *oblique vein of Marshall* (vena obliqua atrii sinistra) from the back of the left auricle opens into the sinus close to the point where it joins the right auricle. The orifice of this vein is devoid of a valve. The oblique vein is very minute, and would not deserve special mention, were it not that it represents the lower pervious part of the obliterated left superior vena cava of the embryo.

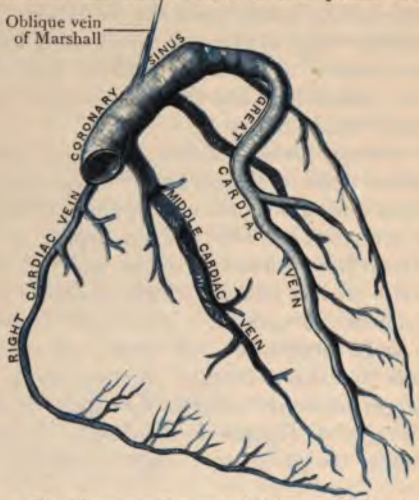

FIG. 26.—The Coronary System of Veins on the Surface of the Heart. (Diagram.)

The *great cardiac vein* (vena cordis magna) begins upon the antero-superior aspect of the heart at the apex. It ascends in the anterior interventricular groove to the auriculo-ventricular furrow, in which it turns round the left margin of the heart to join the coronary sinus. On its way it is joined by numerous veins from the surface of both the ventricular and auricular parts of the heart.

The *anterior cardiac veins* will be seen on the front surface of the right ventricle. They open directly into the right auricle.

But, in addition to those veins which appear upon the surface, there are minute vessels in the substance of the heart —the *venæ Thebesii* or *venæ minimæ cordis*—the orifices of which will be recognised, when the right auricle is opened, as the foramina Thebesii.

The cardiac veins, therefore, which drain the blood from the heart, do not correspond with the arteries. The following table expresses the arrangement in a brief form :

Upon the surface of the heart.	Great cardiac vein. Posterior cardiac veins. Right cardiac vein. Oblique vein.	*Opening into* coronary sinus.
	Anterior cardiac veins.	*Opening into* right auricle.
In the substance of the heart.	Venæ Thebesii.	*Opening into* right auricle.

It is only in a heart which has been specially injected that all these veins can be seen. The general arrangement, however, can usually be studied in the course of an ordinary dissection. In certain cases, where the veins are empty and the fat on the surface of the heart scanty, they may be inflated with air by introducing a blow-pipe into some of the larger members of the series.

Cardiac Nerves.—For the most part the fine nerves which form the superficial cardiac plexus are prolonged downwards upon the pulmonary artery, and being joined by a considerable reinforcement from the deep cardiac plexus, they form the *right coronary plexus* which is distributed in the course of the right coronary artery. The *left coronary plexus* which accompanies the artery of the same name is derived from the deep cardiac plexus. The nerves do not slavishly follow the arteries ; they soon leave the vessels, and are ultimately lost in the substance of the heart. Here and there ganglia are developed in connection with them.

Dissection. —The chambers of the heart should now be opened in the order in which the blood flows through them. Begin with the right auricle, and, to bring it fully into view, draw the heart well over to the left side of the body. Two cuts are required—(1) A vertical incision from the point at which the superior vena cava enters the auricle to the point of entrance of the inferior vena cava. In making this incision, care must be taken not to injure the Eustachian valve—a fold of endocardium placed in front of the mouth of the inferior vena cava. (2) An oblique incision carried from about the middle of the first cut to the tip of the auricular appendix. The dark venous blood should be washed away from the interior of the auricle with a sponge.

When the dissector has fully studied the interior of the right auricle, he may slit open with the scissors the superior vena cava and the two innominate veins. By this proceeding he may satisfy himself that *no valves* are present in these vessels.

Right Auricle (atrium dextrum).—The internal surface of the cavity presents a polished glossy appearance, due to its endocardial lining. In the auricular appendix the wall is raised into a series of closely applied parallel muscular ridges, called the *musculi pectinati*, from their resemblance to the teeth of a comb. These ridges are also present on the right wall of the auricle, and when followed backwards they are seen to end on a smooth vertical ridge, called the *crista terminalis* (Figs. 27 and 28). It represents in the interior of the auricle the groove on the exterior already described under the name of the sulcus terminalis. In the intervals between the musculi pectinati the wall of the auricle is very thin. To the left of the crista terminalis the walls of the auricle are smooth from the absence of musculi pectinati, and it is into this part that the veins open.

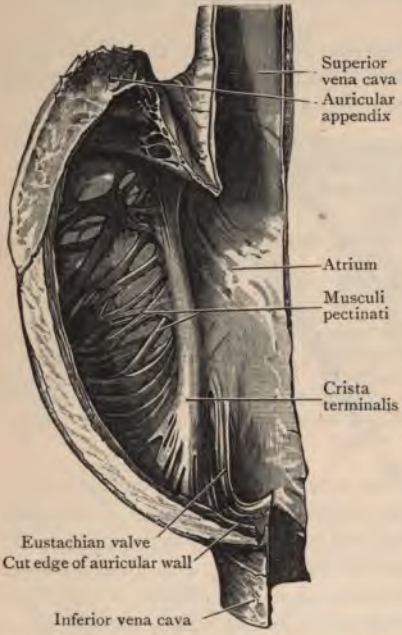

FIG. 27.—A portion of the Right Auricle from same specimen as that depicted in Fig. 22.

The auricular part of the heart has been divided in the line of the two caval veins, the anterior wall of the right auricle removed, and then the specimen turned slightly over to the right so as to give a view of the interior of the appendix, etc. The specimen was hardened *in situ*.

The blood enters the atrium of the auricle by the following openings:—(1) the opening of the superior vena cava; (2)

the opening of the inferior vena cava; (3) the opening of the coronary sinus; (4) the orifices of three or four anterior cardiac veins from the surface of the right ventricle; (5) the foramina Thebesii.

The blood flows out of the cavity, into the right ventricle, through the large auriculo-ventricular opening.

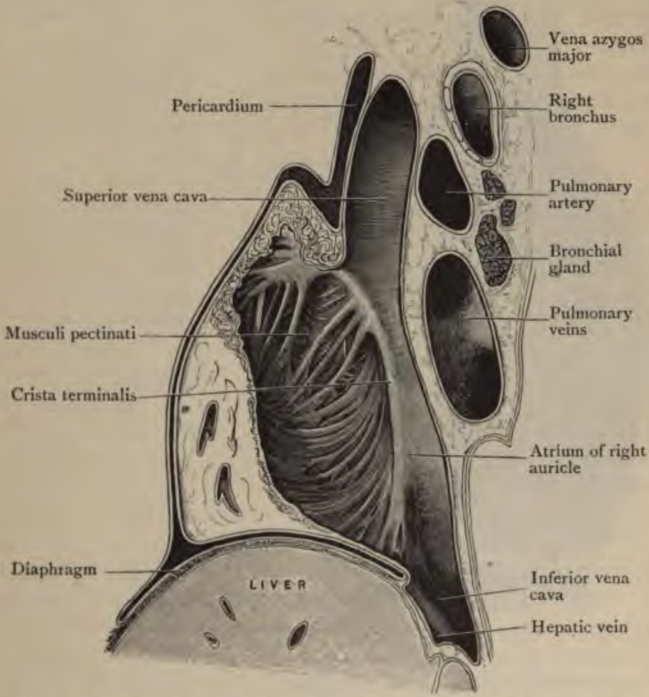
Vena azygos major
Pericardium
Right bronchus
Superior vena cava
Pulmonary artery
Bronchial gland
Pulmonary veins
Musculi pectinati
Crista terminalis
Atrium of right auricle
Diaphragm
LIVER
Inferior vena cava
Hepatic vein

FIG. 28.—Sagittal section through the Right Auricle of the Heart and the Root of the Right Lung.

The orifice of the *superior vena cava* is situated at the upper and back part of the auricle. It should be noted that this aperture is devoid of a valve, and that the upper end of the crista terminalis is continuous with the sharply defined anterior border of the opening. The *inferior vena cava* opens into the lower part of the cavity, and has the rudimentary *Eustachian valve* in relation to its orifice. The dissector should note that these two veins are so directed that the currents of blood, which flow from them into the auricle, shall not be opposed the one against the other.

The *auriculo-ventricular orifice* is the large, oval opening situated in the anterior wall of the atrium of the auricle (Fig. 22, p. 44). Through this aperture three fingers can be readily passed in to the ventricle. If the student now looks between this opening and the orifice of the inferior vena cava, he will discover the mouth of the *coronary sinus*, imperfectly guarded by a fold of endocardium, which receives the name of the *coronary valve* or *valve of Thebesius*. An attentive examination of the inner surface of the auricular wall will further reveal several minute, round, irregularly scattered openings called the *foramina Thebesii*. Some of these are simply small cæcal pits in the substance of the heart, whilst others are the mouths of minute veins—the *venæ Thebesii*.

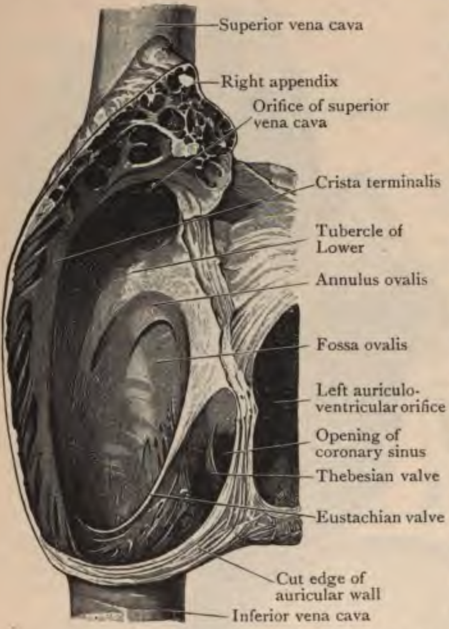
Superior vena cava
Right appendix
Orifice of superior vena cava
Crista terminalis
Tubercle of Lower
Annulus ovalis
Fossa ovalis
Left auriculo-ventricular orifice
Opening of coronary sinus
Thebesian valve
Eustachian valve
Cut edge of auricular wall
Inferior vena cava

FIG. 29.—Interior of Right Auricle as seen by the removal of the anterior wall, or that wall opposed to the base of the Ventricles. This is a part of the same specimen that is depicted in Fig. 22.

Examine, in the next place, the partition which separates the two auricles from each other (*septum atriorum*). Upon this an oval depression, surrounded by a prominent ridge, will be noticed a short distance above the mouth of the inferior vena cava. The depression is called the *fossa ovalis*. Its floor is exceedingly thin, and it marks the position of the *foramen ovale* of the fœtal heart. The ridge which encircles it is deficient below. It is, therefore, crescentic in form, and is called the *annulus ovalis* (limbus fossæ ovalis). In a few cases, a communication between the two auricles may be found by slipping a probe under the upper and best-marked part of the annulus. Stretching between the anterior horn of the annulus ovalis and the anterior margin of the mouth of the inferior vena cava is a crescentic fold of endocardium, sometimes cribriform and often very feebly marked, called the *Eustachian valve.* The interauricular septum in the interval between the fossa ovalis and the mouth of the superior vena cava exhibits a slight prominence. This is termed the *tubercle of Lower.*

Dissection.—The right ventricle may now be opened by the following incisions:—(1) An incision through the wall of the ventricle extending from a short distance below the auriculo-ventricular groove along the sharp margin of the heart to the lower end of the anterior interventricular furrow. (2) A transverse incision, through the anterior wall of the ventricle, from the upper end of the first incision to the upper end of the anterior interventricular furrow. This cut should be made parallel to the auriculo-ventricular groove, and about half an inch below it. Both incisions must be made with care and deliberation, but more especially the second one. In this case the auriculo-ventricular valve is liable to injury, and it is well to protect it by introducing the forefinger of the left hand through the auriculo-ventricular opening into the ventricle.

The anterior wall of the right ventricle can, in this way, be raised in the form of a V-shaped flap and turned to the left. Wash away the blood and clots.

Right Ventricle (ventriculus dexter).—The cavity of the right ventricle, now laid open and exposed to view, is of a somewhat triangular form, the base being directed backwards, and the apex forwards and downwards towards the apex of the heart. It does not reach the apex of the heart, however, but corresponds to the junction of the anterior and inferior interventricular furrows around the sharp margin of the heart. On transverse section, the cavity of the right ventricle is semilunar in outline, owing to the thick fleshy interventricular septum which constitutes its inner wall bulging into it (Fig. 30). The wall is thickest at its upper part, and thins slightly towards the apex.

With the exception of the conus arteriosus or infundibulum, from the summit of which the pulmonary artery arises, and the interior of which is smooth and even, the inner surface of the walls of the right ventricle is rendered extremely irregular by the projection of a lace-work of fleshy ridges called *columnæ carneæ* (trabeculæ carneæ). It is customary to describe these as presenting three different forms—(*a*) simple elongated ridges; (*b*) fleshy slips or trabeculæ free throughout the greater part of their extent, but fixed to the wall by their two extremities; (*c*) conical fleshy projections of considerable size, which project into the cavity, and are attached by their bases only. These last are called *musculi papillares*, and are arranged so as to form an anterior and a posterior set. The free end of each of these papillary muscles gives origin to several delicate thread-like tendons—the *chordæ tendineæ*—and by these they are brought into connection with the segments of the auriculo-ventricular valve. A transverse fleshy band will be noticed to spring from the base of the anterior papillary muscle, and stretch across the ventricular cavity to the septum, to which it is attached. This is the *moderator band*. By fixing the yielding anterior wall of the ventricle to the more solid septum, it is said to prevent over-distension of the cavity.

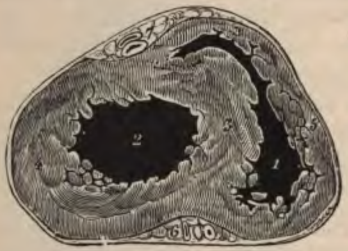

FIG. 30.—Transverse section through the Ventricular Part of the Heart. (From Luschka.)

1. Cavity of right ventricle.
2. Cavity of left ventricle.
3. Ventricular septum.
4. Thick wall of left ventricle.
5. Thinner wall of right ventricle.
6. Inferior interventricular furrow with middle cardiac vein and inferior branch of right coronary artery.
7. Anterior interventricular furrow, with great cardiac vein and anterior branch of left coronary artery.

There are two openings in the right ventricle—(1) the *auriculo-ventricular*, which gives admission to the stream of blood; (2) the *pulmonary*, through which the blood passes into the pulmonary artery. Both these openings are situated at the base of the ventricle. The large oval auriculo-ventricular orifice lies to the right and behind, whilst the pulmonary aperture is placed to the left, above and in front of the other, and at the summit of the conus arteriosus. Both of these openings are guarded by valves, which act so as to give the blood its proper direction through the heart.

The valve which guards the mouth of the pulmonary artery is composed of three semilunar segments, and is called the *semilunar* or the *sigmoid valve.* By looking upwards into the lumen of the artery, a view of these segments may be obtained, but it is better to defer their examination until the vessel itself has been studied.

Right Auriculo-Ventricular or Tricuspid Valve (valvula tricuspidalis).—This valve is composed of three triangular, pointed, membranous segments, termed *cusps*, which project forwards into the cavity. These are united by their bases so as to form an annular membrane, and, through the intermediation of this, they are fixed around the auriculo-ventricular opening. In the intervals between these larger segments three smaller cusps may frequently be detected.

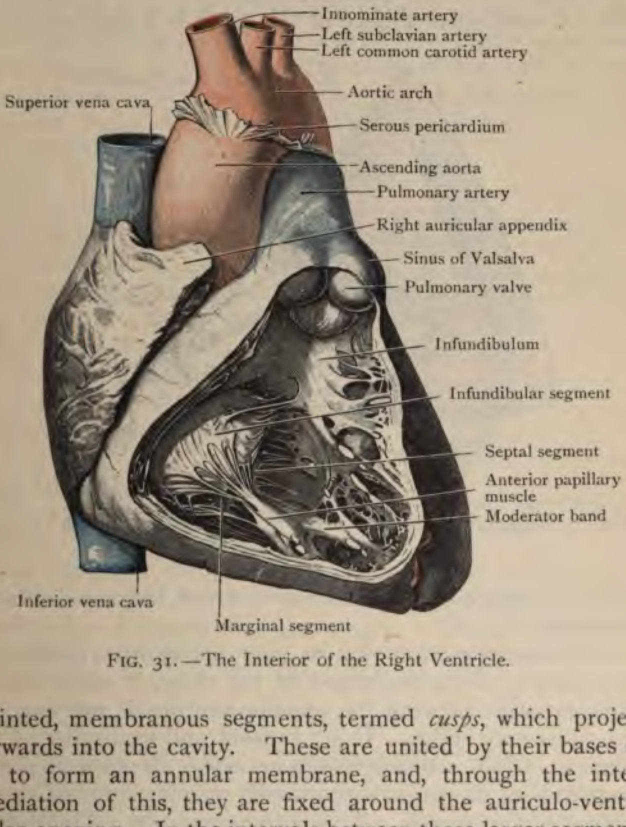
Innominate artery
Left subclavian artery
Left common carotid artery
Aortic arch
Superior vena cava
Serous pericardium
Ascending aorta
Pulmonary artery
Right auricular appendix
Sinus of Valsalva
Pulmonary valve
Infundibulum
Infundibular segment
Septal segment
Anterior papillary muscle
Moderator band
Inferior vena cava
Marginal segment

FIG. 31.—The Interior of the Right Ventricle.

Each cusp is composed of two layers of endocardium, between which there is a certain amount of fibrous tissue. This fibrous tissue is, for the most part, confined to the central portion of the cusp, the margins of which are therefore thin and translucent. When the valve is in action, it prevents regurgitation of blood into the auricle during the contraction of the ventricular wall. Attached to the ventricular surface and margin of each segment, as well as into the circumference of the auriculo-ventricular opening, are several of the chordæ tendineæ which have been seen to take origin from the apices of the papillary muscles. In consequence of this, the ventricular surface of the valve is rough, whilst the auricular surface—that surface over which the blood flows—is smooth.

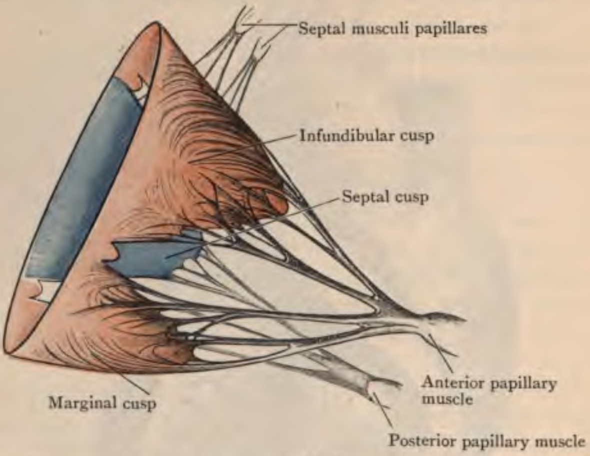
Septal musculi papillares
Infundibular cusp
Septal cusp
Anterior papillary muscle
Marginal cusp
Posterior papillary muscle

FIG. 32.—Diagram of the arrangement of the Cusps and Chordæ Tendineæ of the Tricuspid Valve.

It is necessary, however, to note the relative position of these cusps. One, the largest of the three, is suspended so as to intervene between the auriculo-ventricular opening and the pulmonary orifice. It lies in front and to the left of the opening. This is the *infundibular cusp*. Another is placed posteriorly to the auriculo-ventricular opening, and lies closely applied to the septum. This is the *septal cusp*. The third is situated to the right, near the anterior sharp margin of the heart, and may be termed the *marginal cusp*. The chordæ tendineæ of the anterior papillary muscle are distributed in the interval between the infundibular and marginal flaps; those from the posterior papillary muscle go to the interval between the marginal and septal flaps; whilst to the interval between the infundibular and septal flaps pass a number of short chordæ tendineæ, some of which spring directly from the septum, whilst others proceed from low, feeble musculi papillares, also connected with the upper part of the septum.

Pulmonary Artery (arteria pulmonalis).—This vessel is a short wide trunk about two inches long. It has an oblique direction upwards and backwards, so as to reach the lower aspect of the aortic arch. It here divides into a *right* and a *left* branch. At first, it lies in front of the root of the aorta, but, as it ascends, it takes a spiral turn round the ascending aorta, so that before it terminates it is placed upon the left side of that vessel (Fig. 21, p. 43). In relation to each side of the pulmonary artery the dissector will notice the corresponding coronary artery and auricular appendix. The vessel is completely enclosed within the fibrous pericardium, the serous layer of which forms a single tubular sheath around it and the ascending aorta.

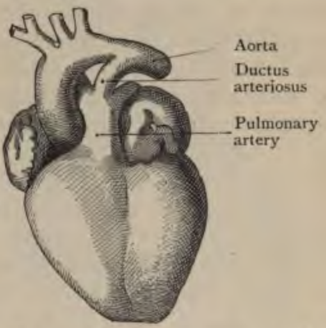

FIG. 33.—Heart of a seven months Fœtus. (From Gegenbaur.)

The *right pulmonary artery* is somewhat longer and larger than the left. It passes transversely outwards behind the ascending aorta and superior vena cava to reach the root of the right lung, where it has already been dissected (Fig. 24, p. 46). The *left pulmonary artery* runs outwards in front of the descending aorta and left bronchus to gain the root of the left lung (Fig. 39, p. 69). The blood is thus conducted from the right ventricle of the heart to the two lungs.

Ligamentum Arteriosum or Obliterated Ductus Arteriosus.—This is a strong fibrous cord which will be observed connecting the upper surface of the root of the left pulmonary artery with the under surface of the aortic arch. The ligamentum arteriosum has the same direction as the trunk of the pulmonary artery. During fœtal life it is the patent continuation of the pulmonary artery, and conducts the blood into the aorta. At this period, the right and left pulmonary arteries are of a small size, and convey a very small part of the blood-stream to the lungs. In dissecting the fibrous remains of the ductus arteriosus, note that the left recurrent laryngeal branch of the pneumogastric nerve hooks round it at its attachment to the aorta.

Dissection.—The pulmonary artery may now be slit open, so as to expose the valve which guards its orifice. This incision must be made carefully, and the knife carried upwards through the wall of the vessel in the interval between two of the three segments which enter into its formation.

Pulmonary Valve.—Each semilunar segment will be observed to be attached by its convex margin, whilst its concave border is free. Three minute pouches are thus formed around the mouth of the vessel, and the openings of these pouches are directed upwards. A good idea of the valve may be obtained by filling the pouches with cotton wadding. The segments consist of a double layer of endocardium, strengthened by intermediate fibrous tissue; and if the free margin of one be taken between the finger and thumb, a minute nodule of cartilage may be felt about its middle. This is the *corpus Arantii.* In structure, these little flaps are similar to the corresponding segments of the aortic valve—only weaker. We shall defer their more particular description, therefore, until the aortic valve is under consideration. Opposite each segment, the wall of the artery shows a slight dilatation or bulging, called the *sinus of Valsalva.* The three segments of the pulmonary valve are so placed that two are in front and one behind the opening (Fig. 31).

Pulmonary Veins (venæ pulmonales).—The blood is conveyed back to the heart by the pulmonary veins. These have already been studied in the roots of the lungs. Two issue from each lung. The *right veins* are longer than the left, and pass inwards behind the superior vena cava and the right auricle. The *left veins* pass in front of the descending aorta (Fig. 39). If the inferior vena cava be now divided and the heart turned upwards, the pulmonary veins will be seen opening into the left auricle upon its posterior aspect.

Dissection.—To open the left auricle, the heart must be turned well over to the right side of the body, and its apex tilted forwards. Enter the knife well back, and carry it obliquely forwards into the auricular appendix. The cavity is usually more or less distended with injection, and after this has been removed the walls should be washed with warm water.

Left Auricle (atrium sinistrum).—The only part of the left auricle which can be seen from the front is its appendix. This is narrower and more elongated than the corresponding portion of the right auricle. Its margin also is more distinctly notched. When laid open it will be seen that the *musculi pectinati* are confined entirely to the appendix. Everywhere else the inner surface of the wall of the left auricle is smooth. On the posterior wall the four openings of the *pulmonary veins* will be seen. In some cases the two pulmonary veins of one or both sides unite before opening into the left auricle. The number of venous orifices is thus reduced. They are not provided with valves. When the interior of the left auricle of a formalin-hardened heart is examined from the front a projecting crescentic ridge is observed to pass downwards on the left wall in front of the orifices of the two left pulmonary veins so as to hide them from view.

A.	Aorta.
P.A.	The right and left pulmonary arteries.
P.V.	Right and left pulmonary veins.
L.A.A.	Left auricular appendix.
M.V.	Mitral orifice.
L.V.	Left ventricle.
R.V.	Right ventricle.
R.A.	Right auricle.
L.A.	Left auricle.
S.V.C.	Superior vena cava.

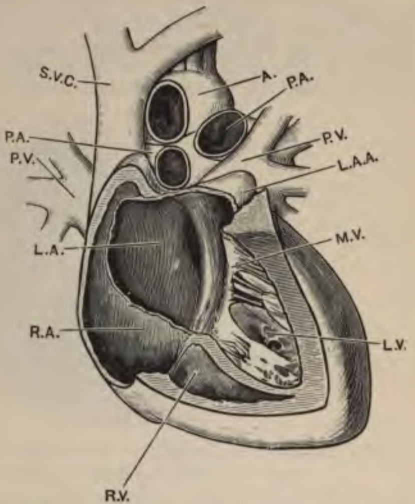

FIG. 34.—Dissection of a Heart hardened *in situ* to show the Left Auricle and the Left Ventricle. The ascending aorta, the anterior cusp of the mitral valve, the trunk of the pulmonary artery, and the interauricular septum and portion of the interventricular septum have been removed. (Stiles.)

In the fore-part of the auricle is the oval *auriculo-ventricular opening*. It only admits the passage of two fingers into the ventricle, and is therefore smaller than the corresponding orifice of the right side. The position of the fœtal *foramen ovale* can also be distinguished upon this side of the septum atriorum, but it is not so well marked as it is in the right auricle. It presents the appearance of a faint depression bounded below by a slightly marked crescentic border. Foramina Thebesii and the small orifices of venæ minimi cordis are also present on the walls of the left auricle.

Dissection.—To open the left ventricle, the dissector should stand upon the right side of the body and grasp the heart with the left hand, so that the forefinger rests upon the upper part of the inferior interventricular furrow, and the thumb upon the upper part of the anterior interventricular furrow. The wall of the ventricle should then be transfixed by a long knife. Enter the knife below the thumb, about half an inch to the left of the anterior furrow, and push it through the ventricular wall towards the forefinger, so that the point emerges below this, and half an inch to the left of the inferior furrow. Now carry the knife downwards towards the apex, but do not allow it to come nearer to the furrows than it was when first entered. If necessary, the cut on each side may be extended upwards towards the base of the ventricle with a small knife.

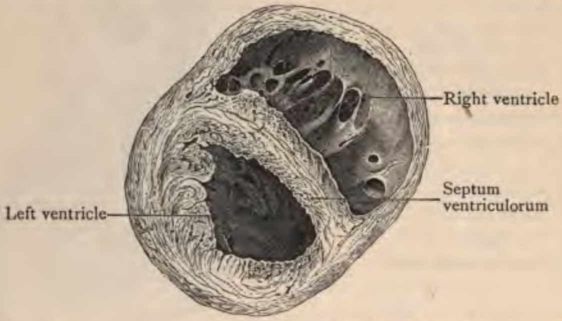

FIG. 35.—Section through the Ventricular Portion of the Heart near the apex. It shows the greater depth of the left ventricle.

Left Ventricle (ventriculus sinister).—The cavity of the left ventricle is longer and narrower than that of the right ventricle. It reaches down to the apex of the heart, and is somewhat conical in shape—tapering towards its lower end. In cross section it presents a circular or broadly oval outline (Fig. 35). The walls of the left ventricle are very much thicker than those of the right ventricle.

When the injection and blood have been washed away m the interior of the left ventricle with hot water, the *columnæ carneæ* will be observed to form dense muscular reticulations on the inner surface of its walls. This network is especially complicated at the apex and on the inferior wall of the cavity. The surface of the septum and the upper part of the anterior wall are, comparatively speaking, smooth. The *musculi papillares*, with their attached chordæ tendineæ, are collected into two strongly marked groups. They are much larger than the papillary muscles of the right ventricle, but do not project so distinctly into the cavity.

The left ventricle has two openings—(1) the auriculo-ventricular opening, through which the blood enters from the auricle; (2) the aortic orifice, through which the blood flows into the aorta. These apertures are situated close together at the base of the ventricle, the *auriculo-ventricular opening* lying behind and to the left, whilst the *aortic orifice* is placed in front and to the right. Both openings are guarded by valves—the auriculo-ventricular opening by the *mitral* or *bicuspid valve*, and the aortic opening by the *aortic valve*.

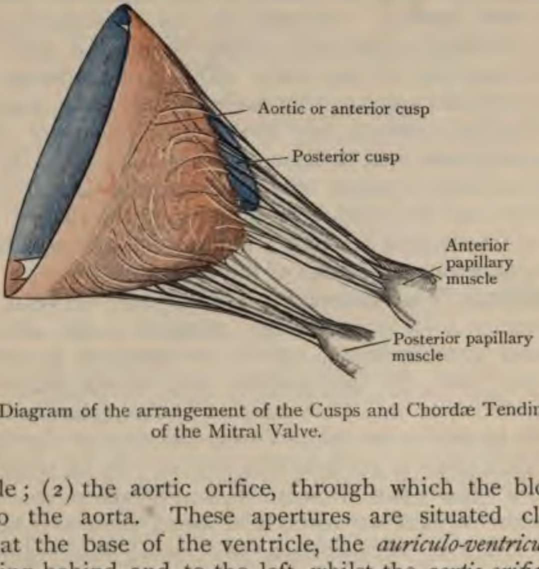

FIG. 36.—Diagram of the arrangement of the Cusps and Chordæ Tendineæ of the Mitral Valve.

Mitral Valve (valvula bicuspidalis).—The mitral valve prevents regurgitation of the blood into the left auricle during the contraction or systole of the ventricles. It consists of two large pointed cusps with two smaller portions intervening. These are similar in structure to the cusps of the tricuspid valve, but the segments are larger and much stronger and thicker. The fibrous tissue between the two layers of endocardium is more abundant, but it is arranged in precisely the same manner. The chordæ tendineæ from each papillary muscle proceed to one of the two intervals between the cusps, and are attached to the adjacent margins and to the ventricular surfaces of the two cusps. The *anterior* or *aortic cusp* is the larger of the two, and lies in front and to the right of the auriculo-ventricular opening, being so placed as to intervene between the latter and the aortic aperture. The *posterior* or *marginal cusp* lies behind and to the left of the opening.

Aortic Opening.—The part of the ventricular cavity immediately below the orifice of the aorta has been termed the *aortic vestibule.* Its walls are not muscular but fibrous, and therefore it does not collapse during the diastole of the ventricular part of the heart. This is of advantage in so far that it affords space for the proper action of the aortic valve.

Looking upwards into the circular mouth of the aorta, the *aortic valve* will be seen. It is similar in all respects to the pulmonary valve, only its segments are stronger and thicker, and the sinuses of Valsalva at the root of the aorta are more strongly marked. The aortic valve will be studied more fully at a later stage of the dissection.

Septum Ventriculorum.—The septum between the two ventricles is a thick fleshy partition,—the anterior and inferior attachments of which are indicated on the surface of the heart by the anterior and inferior interventricular furrows. Now that both surfaces of the septum are exposed, it will be seen to be thickest near the apex of the heart, and to thin slightly in an upward direction. In its basal and fore part a small portion may be noted which is completely destitute of muscular tissue, and which consists merely of the two layers of endocardium, with some intervening fibrous tissue. This portion is termed the *pars membranacea septi*, and it is of interest from the fact that it is at this point that congenital deficiency of the septum is most liable to occur. The pars membranacea septi forms a portion of the wall of the aortic vestibule, and lies immediately below the contiguous ends of the anterior and right posterior flaps of the aortic valve.

Action of the Heart.—The above details will be dry and meaningless nless they are looked at in connexion with the action of the heart during e. It is impossible to understand the construction of the heart unless we study at the same time its function. During life, the blood is driven through and from the heart by means of successive rhythmical contractions and dilatations of its walls. But the entire heart does not contract simultaneously. First, the auricles contract together, and this is succeeded by the contraction of the ventricles; in other words, the auricular contractions correspond to the ventricular dilatations, and *vice versa*. But, again, there is a period immediately preceding the auricular contraction, during which the entire heart is at rest, and this is called the period of cardiac rest. These three conditions of the walls of the heart—viz., (*a*) the cardiac rest, (*b*) the auricular contraction, (*c*) the ventricular contraction—follow each other consecutively and without intermission, the one after the other; and they are collectively termed "a cardiac revolution." Let us study what is going on inside the heart during each of these three stages.

During the *period of cardiac rest* the auricles are filling. Blood is flowing into the right auricle through the openings of the superior vena cava, inferior vena cava, and the coronary sinus; and into the left auricle through the orifices of the four pulmonary veins. A portion of this blood trickles through the auriculo-ventricular openings into the ventricles; but the blood is passing into the auricles in greater quantity than it is trickling into the ventricles, and the result is, distension of the auricles. The second stage of the cardiac revolution now takes place—viz., *the auricular contraction*. The auricles contract sharply and suddenly, and the blood is forced through the auriculo-ventricular orifices into the ventricles. But how is it that the blood, during this contraction, does not regurgitate into the veins, the mouths of which are devoid of valves? For the simple reason that the contraction begins at the venous orifices and auricular appendices, and travels towards the auriculo-ventricular openings. The ventricles are now full, and the third stage of the cardiac revolution takes place—viz., *the ventricular contraction*. The ventricles contract more slowly, and more deliberately than the auricles, and the blood is discharged into the pulmonary artery and into the aorta. Regurgitation of blood through the auriculo-ventricular openings into the auricles is prevented by the apposition of the segments of the tricuspid and bicuspid valves; and when the ventricular contraction ceases, regurgitation from the arteries into the ventricles is prevented by the semilunar valves being thrown across the arterial orifices.

The segments of the auriculo-ventricular valves are retained in position, and prevented from being forced upwards into the auricle during the ventricular contraction, by the musculi papillares and the chordæ tendineæ. As the ventricular wall in its contraction to a certain extent advances towards the auriculo-ventricular opening, the musculi papillares, in their contraction, retreat from it, and keep the tendinous cords tense—never allowing them to slacken. When the contraction of the ventricle ceases, and the *vis a tergo* is removed from the blood, the recoil of the expanded elastic wall of the artery exerts a pressure upon the column of blood. Its backward flow is prevented by the filling of the pouches of the semilunar valve.

Topography of the Heart.—The *outline of the heart* may be delineated on the anterior surface of the chest as follows:—(1) draw a curved line convex outwards from the sternal end of the third right costal cartilage to the sternal end of the sixth right costal cartilage; this line should attain its point of maximum convexity as it crosses the fourth intercostal space, and this point should be 1½ inches from the middle line; the line thus drawn will correspond to the right outline of the right auricle; (2) connect by a straight line the sternal end of the sixth right costal cartilage with the point on the chest wall which corresponds to the apex of the heart; this gives the lower limit of the heart, and for the most part it corresponds with the margo acutus; (3) from the apex of the heart draw a third line slightly curved outwards to the sternal end of the second left costal cartilage; this line follows on the surface the outline of the margo obtusus and the appendix of the left auricle.

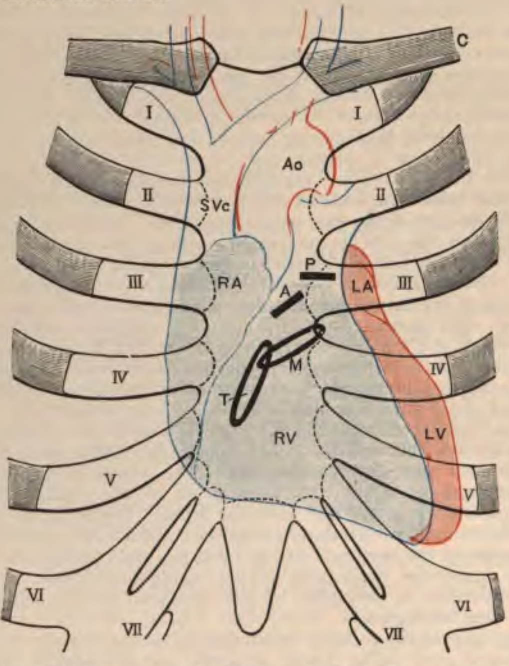

FIG. 37.—The relations of the Heart and of its Orifices to the Anterior Thoracic Wall. (Young and Robinson.)

I to VII. Costal cartilages.
A. Aortic orifice.
Ao. Aorta.
C. Clavicle.
LA. Left auricle.
LV. Left ventricle.

M. Mitral orifice.
P. Pulmonary orifice.
RA. Right auricle.
RV. Right ventricle.
SVc. Superior vena cava.
T. Triscuspid orifice.

An oblique line extending across the front of the sternum from the middle line at the level of the third costal cartilage to the sternal end of the sixth right costal cartilage indicates on the surface the position of the *auriculo-ventricular groove.*

The *pulmonary aperture* is the most superficial of the cardiac orifices, and lies behind the upper part of the junction of the third left costal cartilage with the left margin of the sternum. The pulmonary artery itself lies behind the anterior end of the second left intercostal space and the second left costo-sternal articulation. The *aortic opening* is placed more deeply and at a slightly lower level. It is situated behind the left margin of the sternum opposite the lower border of the junction between the third left costal cartilage and the sternum. The *right auriculo-ventricular orifice* lies behind the sternum, opposite the extremity of the fourth intercostal space of the right side. The *left auriculo-ventricular opening* is very deeply placed. It is situated behind the left margin of the sternum at the level of its junction with the fourth left costal cartilage.

Dissection.—The aorta should now be examined, and the various structures in relation to it must be carefully dissected out.

Aorta.—The aorta is the great arterial trunk which conveys blood from the left ventricle of the heart, and distributes it by means of its branches to every part of the body. After leaving the heart it arches over the root of the left lung, and proceeds downwards in front of the vertebral column. It leaves the thoracic cavity by passing through a special opening in the diaphragm, and it ends in the abdominal cavity upon the left side of the body of the fourth lumbar vertebra, by dividing into the two common iliac arteries. The part of this great vessel which is contained within the chest is divided, for convenience in description, into three portions: viz., *the ascending aorta*, the *arch of the aorta*, and the *descending thoracic aorta.*

The *ascending aorta* takes origin from the base of the left ventricle of the heart, and proceeds obliquely upwards and to the right behind the sternum. It also inclines, to some extent, forwards, so as to approach more closely to the anterior wall of the chest. Reaching the level of the upper border of the *second costal cartilage* of the *right side*, it changes its direction, and passes into the aortic arch. In the first instance the *aortic arch* bends upwards and to the left in front of the trachea, and then turns suddenly backwards so as to gain the left side of the lower border of the body of the *fourth dorsal vertebra.* Here the vessel makes a bend in a downward direction, and becomes continuous with the *descending thoracic aorta.*

Ascending Aorta (aorta ascendens).—The ascending aorta takes origin from the base of the left ventricle behind the left margin of the sternum opposite the lower border of the third costal cartilage. From this it passes upwards, and to the right, and ends in the aortic arch behind the right margin of the sternum at the level of the upper border of the second costal cartilage. Throughout its entire length it is enclosed within the fibrous pericardium, whilst the same sheath of serous pericardium surrounds it and the pulmonary artery. It is therefore placed within the middle mediastinum (Figs. 31 and 39, pp. 57 and 69).

It does not possess a uniform diameter. At its root, opposite the segments of the aortic valve, it presents the three bulgings termed the sinuses of Valsalva; whilst higher up, on cross section, it generally exhibits a transversely oval and not a circular outline. This is due to the presence of a diffuse bulging of the right wall, which receives the name of the *great aortic sinus*. Against the wall of this sinus the blood is driven with great force as it leaves the ventricle, and

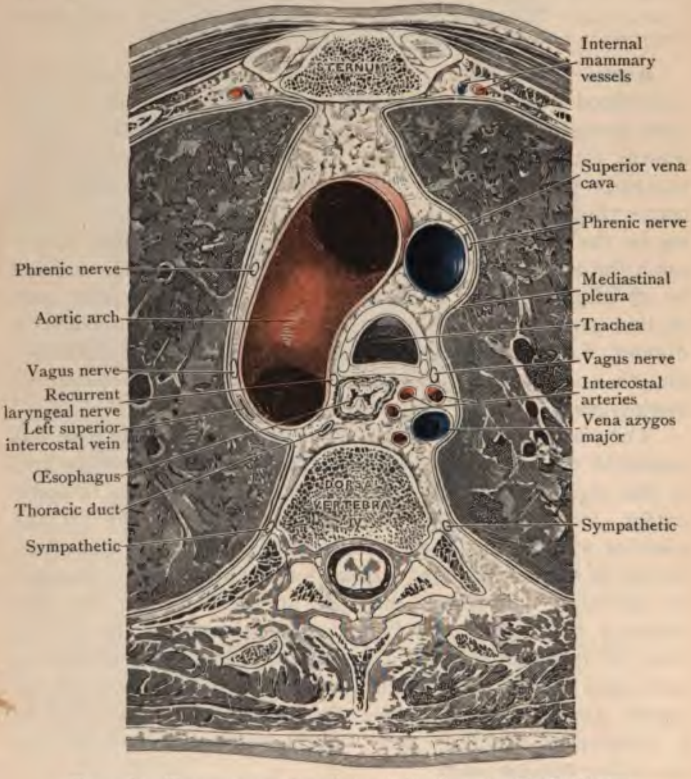
Internal mammary vessels
STERNUM
Superior vena cava
Phrenic nerve
Phrenic nerve
Mediastinal pleura
Aortic arch
Trachea
Vagus nerve
Vagus nerve
Recurrent laryngeal nerve
Intercostal arteries
Left superior intercostal vein
Vena azygos major
Œsophagus
DORSAL VERTEBRA IV
Thoracic duct
Sympathetic
Sympathetic

FIG. 38.—Transverse section through the Superior Mediastinum at the level of the fourth dorsal vertebra.

at first sight it might seem to be aneurismal in its origin, but its presence in the fœtus renders such a view untenable. It is, however, a favourite site for aneurismal dilatation.

The more immediate relations of the ascending aorta may now be examined. It is intimately associated with the pulmonary artery throughout its entire length. At its origin it lies behind the root of the pulmonary artery; higher up, this vessel is placed to the left of the ascending aorta. To its right side, and partly behind it, is the superior vena cava; whilst behind, it is in relation to the anterior wall of the right auricle and the right pulmonary artery (Fig. 24, p. 46). It is overlapped by the right pleura and the anterior thin margin of the right lung, which intervene between it and the chest wall.

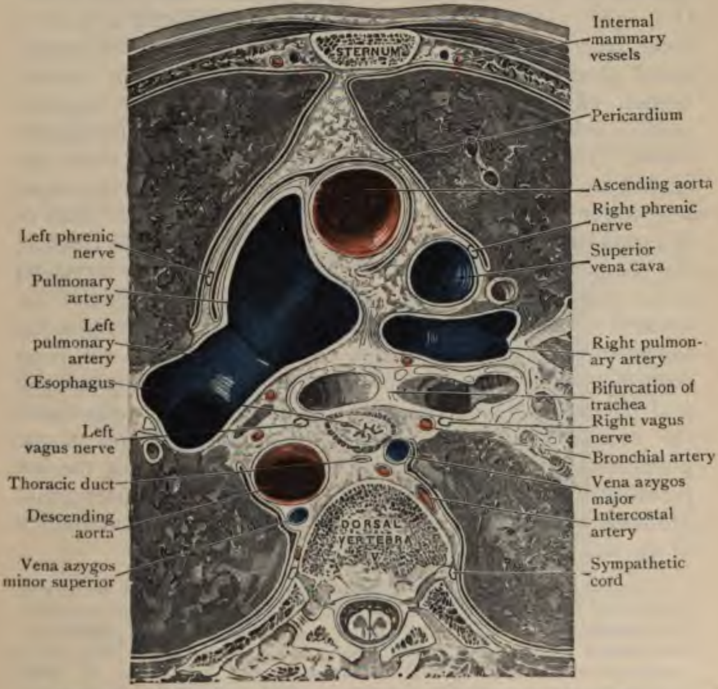
STERNUM
Internal mammary vessels
Pericardium
Ascending aorta
Right phrenic nerve
Superior vena cava
Left phrenic nerve
Pulmonary artery
Left pulmonary artery
Right pulmonary artery
Œsophagus
Bifurcation of trachea
Right vagus nerve
Left vagus nerve
Bronchial artery
Vena azygos major
Thoracic duct
Intercostal artery
Descending aorta
DORSAL VERTEBRA
Vena azygos minor superior
Sympathetic cord

FIG. 39.—Transverse section through the Mediastinal Space at the level of the fifth dorsal vertebra.

The *coronary arteries* have already been seen to spring from this portion of the aorta.

Aortic Arch (arcus aortæ).—The arch of the aorta extends from the termination of the ascending aorta to the left side of the body of the fourth dorsal vertebra. It is placed within the superior mediastinum, and the left pleura is applied to its left aspect throughout almost its entire extent (Fig. 38). It lies behind the manubrium sterni, and as it turns backwards it is crossed, under cover of the left mediastinal pleura, by the left phrenic nerve, the inferior cardiac branch of the left pneumogastric nerve, the left superior cardiac branch of the sympathetic, and the left pneumogastric nerve. The left superior intercostal vein ascends upon this surface of the great vessel in the interval between the vagus and phrenic nerves. At first the aortic arch lies in front of the trachea; afterwards it is placed to the left of the trachea, the œsophagus, thoracic duct, and the left recurrent laryngeal nerve (Fig. 38). The *upper border* of this subdivision of the aorta is in relation to the left vena innominata, and from this aspect of the vessel three large arteries take origin, viz., from right to left—(*a*) the innominate, (*b*) the left common carotid, and (*c*) the left subclavian. Its *lower surface*, which forms the concavity of the arch, overhangs the bifurcation of the pulmonary artery, and is connected with the root of the left pulmonary artery by the fibrous ligamentum arteriosum. Hooking round this surface is the recurrent laryngeal branch of the left vagus nerve.

Dissection.—The three large branches which spring from the aortic arch carry blood for the supply of the two upper limbs and the head and neck. They should now be dissected. The left common carotid takes origin somewhat nearer the innominate artery than the left subclavian. They are all contained within the superior mediastinum, and Fig. 40, p. 71, which is taken from a tracing of a transverse section through the upper part of this space a short distance above the level of the aortic arch, shows their more important relations.

Innominate Artery (arteria anonyma).—The innominate artery is the largest of the three branches which spring from the aortic arch. It passes obliquely upwards and to the right in the superior mediastinum, and, gaining the posterior aspect of the right sterno-clavicular articulation, ends behind the upper margin of the clavicle, by dividing into the right common carotid and right subclavian arteries. *In front* of the vessel are the remains of the thymus gland and the manubrium sterni, to the posterior aspect of which are attached the sterno-hyoid and sterno-thyroid muscles. Further, the artery is crossed superficially, and close to its origin, by the left vena innominata. *Behind* is the trachea ; but as the vessel inclines to the right, it comes to lie, at a higher level, upon the right side of the windpipe. To the *right side* of the artery, in its upper part, are the pleura, the right innominate vein, the superior vena cava, and the right phrenic nerve.

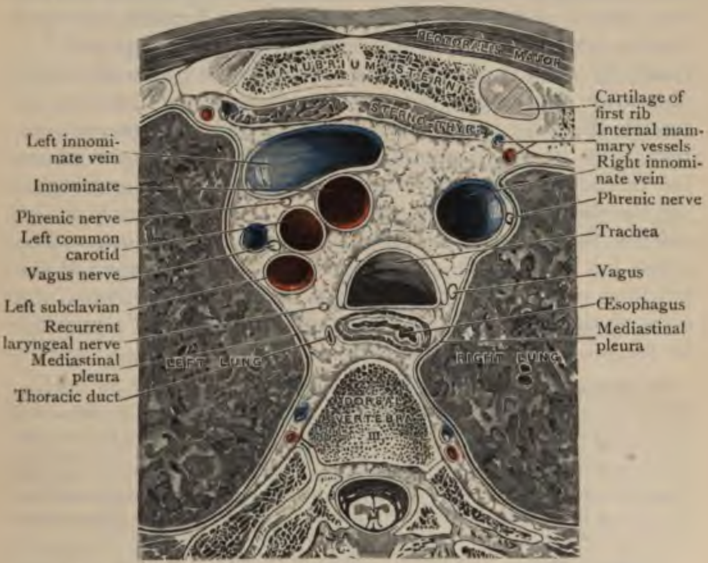
PECTORALIS MAJOR
MANUBRIUM STERNI
STERNO-THYR.
Cartilage of first rib
Internal mammary vessels
Right innominate vein
Phrenic nerve
Trachea
Vagus
Œsophagus
Mediastinal pleura
Left innominate vein
Innominate
Phrenic nerve
Left common carotid
Vagus nerve
Left subclavian
Recurrent laryngeal nerve
Mediastinal pleura
Thoracic duct
LEFT LUNG
RIGHT LUNG
DORSAL VERTEBRA III.

FIG. 40.—Transverse section through the Superior Mediastinum at level of the third dorsal vertebra.

With the exception of the two trunks into which it divides, the innominate artery gives off no branches. The *thyroidea ima*, an occasional artery, may be seen to spring from it in some cases.

Left Common Carotid Artery (arteria carotis communis sinistra).—This artery ascends in the superior mediastinum to the posterior aspect of the left sterno-clavicular articulation. At this point it leaves the thorax and enters the neck. It lies deeply in the thorax, at a greater distance from the manubrium sterni than the innominate artery. *In front* of the left common carotid artery are the remains of the thymus gland, and the left vena innominata, which crosses it. *Behind*, it is in relation, in the first instance, to the trachea, and higher up to the œsophagus and thoracic duct. To its *left side* are the left phrenic and vagus nerves. Further, it is supported on the left side by the left pleura and lung. It gives off no branches within the thoracic cavity.

Left Subclavian Artery (arteria subclavia sinistra).—This vessel springs from the aortic arch, near its termination, and lies very deeply in the superior mediastinum. It takes a vertical course upwards towards the thoracic inlet, through which it passes by arching outwards over the cervical pleura and apex of the left lung to gain the upper surface of the first rib. *In front* is the left common carotid artery, the left vena innominata, and the left pneumogastric nerve. To *its right side* are the trachea and the left recurrent laryngeal nerve, and higher up, the œsophagus and thoracic duct. *Behind* and to *its left side* are the left mediastinal pleura and the left lung. The artery lies in a groove on the inner aspect of the apex of the left lung, and, before the dissection of the mediastinum, if the apex of the lung be pulled outwards, the injected artery will be seen to bulge into the pleural cavity.

Dissection.—The deep cardiac plexus should now be dissected. Divide the aortic arch at its commencement and termination. Two ligatures should be placed around the vessel at each of these points and the section made between them. This is done to prevent the escape of the injection with which the artery is filled. The superior vena cava may also be severed immediately below the point where it is joined by the vena azygos major. By cutting the fibrous ductus arteriosus the aortic arch can be drawn aside so as to expose the trachea and the cardiac nerves in relation to it.

Cardiac Plexus (plexus cardiacus).—There are three large nerve plexuses, formed in front of the vertebral column, in connexion with the sympathetic system. One of these, the *cardiac plexus*, is situated within the thorax; the other two, the *solar* and the *hypogastric* with its pelvic prolongations, are placed within the abdomen.

The *cardiac plexus* is subdivided into a *superficial* and a *deep* portion, but these are in direct connexion with each other, and are to be regarded merely as different parts of one plexus. The *deep cardiac plexus* is further massed in two portions—a right and a left—which are united across the middle line by many communicating filaments.

The *superficial cardiac plexus* is small in comparison with the deep plexus. It has already been examined, and has been observed to lie in the concavity of the aortic arch in front of the bifurcation of the pulmonary artery. The *deep cardiac plexus* is situated behind the aortic arch upon the lower end of the trachea. It is therefore placed on a deeper plane and at a slightly higher level than the superficial plexus. The branches which enter the different parts of the cardiac plexus are derived from the cervical portions of the gangliated cords of the sympathetic, from the pneumogastric nerves, and from the recurrent laryngeal nerves.

The *sympathetic cardiac branches* which arise in the neck are three in number on each side—one from each cervical ganglion —and they are termed respectively the *upper*, *middle*, and *lower sympathetic cardiac branches*. The upper sympathetic cardiac branch of the left side has already been traced across the aortic arch into the superficial cardiac plexus.

The *middle* and *lower* branches of the left side join the left portion of the deep cardiac plexus on the trachea. The *three* sympathetic cardiac branches of the *right side* join the right portion of the deep plexus. Within the thorax they run obliquely downwards and inwards behind the innominate artery to reach their destination on the side of the trachea.

The cardiac branches of the pneumogastric nerves are given off partly in the neck, and partly in the thorax. The *cervical branches* are two in number, viz., superior and inferior. The *inferior cervical cardiac branch* of the left pneumogastric has been previously traced over the aortic arch into the superficial cardiac plexus. Both branches on the right side proceed downwards behind the subclavian artery, and then along the trachea to join the right portion of the deep cardiac plexus. The upper branch of the left side joins the left part of the deep cardiac plexus.

Thoracic cardiac branches are only given off from the trunk of the right pneumogastric. They join the right portion of the deep plexus.

The recurrent laryngeal branches of the pneumogastric nerves also supply cardiac twigs to the deep plexus. *On the left side*, where the recurrent laryngeal hooks round the arch of the aorta, these branches are more numerous, and replace the thoracic cardiac branches of the left pneumogastric. The following table shows the arrangement of the cardiac nerves with reference to the plexus :—

Superficial cardiac plexus, . .	1. Superior cardiac branch of sympathetic of left side.
	2. Lower cervical cardiac branch of left pneumogastric.
Left portion of the deep cardiac plexus, ...	1. Middle and lower cardiac branches of the sympathetic of left side.
	2. Upper cervical cardiac branch of the pneumogastric.
	3. Cardiac branches of the left recurrent laryngeal.
Right portion of the deep cardiac plexus, ...	1. Three cardiac branches of sympathetic of right side.
	2. Both cervical cardiac branches of the right pneumogastric.
	3. Thoracic cardiac branches of the right pneumogastric.
	4. Cardiac branches of the right recurrent laryngeal.

The manner in which the different offsets from the cardiac plexus are distributed has, to a certain extent, been examined. From the right portion of the deep plexus proceed—(1) an offset to join the right anterior pulmonary plexus; (2) an offset for the supply of filaments to the right auricle of the heart; and (3) a very considerable prolongation, which passes downwards in front of the right pulmonary artery to join the superficial cardiac plexus, and form the *right coronary plexus* (p. 51).

From the left portion of the deep cardiac plexus proceed —(1) an offset to the left auricle; (2) an offset to the left anterior pulmonary plexus; whilst (3) the greater part of it is prolonged downwards in relation to the left pulmonary artery to form the *left coronary plexus* (p. 51).

Removal of the Heart from the Body.—To do this it is only necessary to divide the pulmonary artery and the pulmonary veins. The other vessels have already been severed. The ascending aorta which is attached to the heart should next be slit open, care being taken to carry the knife accurately between two of the segments of the valve so as not to injure either.

Aortic Valve.—This valve may now be studied and compared with the pulmonary valve which guards the mouth of the pulmonary artery. The membranous valve segments are three in number, and are of semilunar form. Attached around the opening by their convex margins, their free concave edges project into the lumen of the vessel. Three little pockets, open towards the interior of the artery, are in this manner produced. In the case of the *pulmonary artery* the segments are arranged so that two are in front and one at the back of the orifice. In the *aorta*, however, one lies at the front and two at the back of the opening, and on looking into the sinuses of Valsalva, which correspond to the segments, the orifices of the coronary arteries will be seen (Fig. 25, p. 47). Note that they are placed, as a rule, opposite the free edges of the corresponding valve segments, and further, that the right artery springs from the anterior sinus of Valsalva, and the left artery from the left posterior sinus of Valsalva. There are no such openings to be seen in the pulmonary artery.

The aortic valve segments are constructed upon a stronger plan than the pulmonary segments, although in both the structure is the same. In the aortic segments the fibrous tissue which intervenes between the two layers of endocardium is more abundant, and the corpora Arantii more apparent. The fibrous tissue is not uniformly distributed throughout the valve segment, as may be seen by placing one of them on the point of the finger. A firm cord runs along the free edge, and also along the attached border. In addition to this, the fibrous tissue is spread out in the segment in a uniform layer, except in two localities called the *lunulæ*. These are semilunar in outline and lie next the free margin—one on either side of the corpus Arantii. These *lunulæ* are thin and transparent, seeing that they are formed of little more than the two opposed layers of endocardium. When the valve is in action and opposing the return of blood into the heart during diastole of the ventricles, the thin lunular portions of the valve segments are closely applied, and afford mutual support to each other. The full brunt of the blood-pressure is borne by the stronger portions of the valve segments.

Cardiac Wall.—The last step in the dissection of the heart consists in the examination of the parts which enter into the formation of the cardiac wall. On the outside, the heart is clothed by *epicardium* or serous pericardium, and on the inside its cavities are lined by the thin smooth *endocardium* which is continuous through the orifices with the lining membrane of the veins and arteries, and takes a large share in the construction of the valve-flaps. Between the epicardium and the endocardium is placed the muscular tissue of the heart, which is termed the *myocardium*. The muscular fibres of the heart are disposed in several layers, in each of which the fibres take a special direction.

But in an ordinary dissecting-room heart very little information can be obtained as to the arrangement of the muscular fibres. The continuity of the walls is destroyed by the openings which have been made to obtain a view of the interior of the different chambers. It is better, therefore, to obtain a fresh sheep's heart. After filling it with a thick mixture of flour and water, it should be boiled for a quarter of an hour. The boiling has the effect of expanding the paste, while at the same time it dissolves the connective tissue, and hardens the muscular fasciculi. When the boiling is completed, the heart should be placed in cold water, and the dissection carried out. The epicardium and the muscular fibres should be torn off without using the cutting edge of the scalpel.

The fibres of the auricles are difficult to dissect; but in the ventricular portion of the heart, the student should be able to make out—(1) that the different layers of muscular fasciculi cross each other obliquely, and are for the most part attached to the fibrous rings which encircle the auriculo-ventricular openings; (2) that the superficial fasciculi are common to both ventricles; (3) that the majority of the fasciculi of the left ventricle bend inwards at the ventricular septum; and (4) that a remarkable spiral or whorled arrangement of fibres (vortex cordis) occurs at the apex of the heart.

Construction of the Ventricular Orifices.—The heart which is obtained in the dissecting-room, however, must not be cast aside, because several very essential and important points may be made out by its further dissection. In the first place, it is easy to determine the relation of the auricles and ventricles. By separating the epicardium from the base of the ventricles and the adjacent part of the auricles, and removing the fat and vessels from the auriculo-ventricular furrow, it will be seen that the muscular tissue which enters into the formation of the ventricular walls is quite distinct from that of the auricular walls. At only one place is there a direct continuity between the muscular tissue of the auricles and that of the ventricles. This connecting bridge is a small slip, termed the auriculo-ventricular bundle, which passes from the septum between the auricles to the septum between the ventricles. It therefore cannot be seen from the outside of the heart.

To expose the auriculo-ventricular bundle the right auricle and right ventricle should be opened from the front, and the anterior half of the right auriculo-ventricular ring removed. The septal cusp of the valve having been detached, a little dissection immediately below the pars membranacea septi will bring the bundle into view as it passes from the septum of the auricles on to the septum of the ventricles. It is easily distinguished on account of its pale colour. At the lower border of the pars membranacea septi it divides into two parts. One part is carried down on the right face of the ventricular septum and the other upon its left face.

The bond of union between the auricles and ventricles consists of two fibrous rings which surround the auriculo-ventricular openings. By removing the auricles with a pair of scissors these can be more fully displayed. It is to these rings that the triangular auriculo-ventricular valve cusps are attached, and it is from them that they derive the fibrous tissue which intervenes between the two layers of endocardium which form them. Two fibrous rings are also placed around the arterial openings, and supply the strengthening fibrous tissue to the semilunar valve segments.

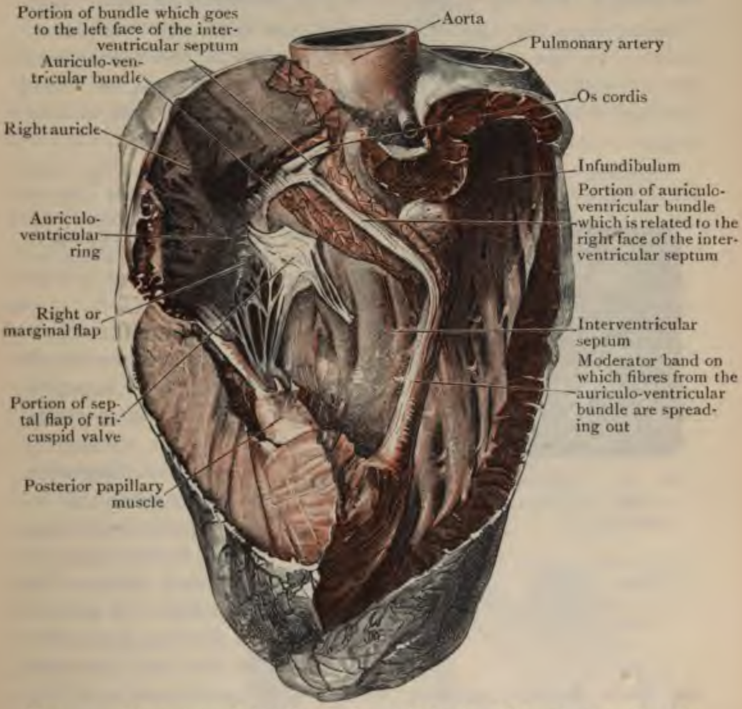
Portion of bundle which goes to the left face of the interventricular septum
Auriculo-ventricular bundle
Right auricle
Auriculo-ventricular ring
Right or marginal flap
Portion of septal flap of tricuspid valve
Posterior papillary muscle
Aorta
Pulmonary artery
Os cordis
Infundibulum
Portion of auriculo-ventricular bundle which is related to the right face of the interventricular septum
Interventricular septum
Moderator band on which fibres from the auriculo-ventricular bundle are spreading out

FIG. 41.—Dissection of the Heart of a Calf by Dr. Waterston to show the Auriculo-ventricular Bundle. This band is regarded as the pathway by which the wave of auricular contraction passes from the auricular to the ventricular wall.

When the auricles are removed from the ventricles, the relative positions of the orifices at the base of the ventricular portion of the heart can be studied (Fig. 25, p. 47). The auriculo-ventricular openings lie side by side below and posteriorly. The aortic opening is placed in front and between them, whilst the pulmonary orifice is situated in front of the aortic opening. A wide interval intervenes between the apertures of the right ventricle: the aortic and left auriculo-ventricular orifices, however, lie close together, and their fibrous rings for a short distance are confluent with each other. In the triangular interval, between the aortic and two auriculo-ventricular openings, there is a mass of fibro-cartilage which stands in intimate connexion with the fibrous rings.

Dissection.—To expose the trachea more fully, separate the right and left pulmonary arteries with the knife, and throw each outwards towards the lung with which it is connected. The aortic arch must be drawn aside, and some bronchial glands which occupy the angle between the bronchi removed.

Trachea.—The thoracic portion of the trachea, or windpipe, traverses the superior mediastinum. It is a wide tube, which is kept constantly patent by a series of cartilaginous rings which are embedded in its walls. Posteriorly these rings are deficient, and in consequence the tube is flattened behind. Its appearance in transverse section may be seen in Fig. 38, p. 68. It begins in the neck opposite the sixth cervical vertebra, where it is continuous with the larynx, and it enters the chest cavity through the thoracic inlet. Here it lies in the superior mediastinal space, and ends by dividing into the two bronchi opposite the intervertebral disc between the fourth and fifth dorsal vertebræ. A short distance above the bifurcation an impression, sometimes strongly marked, is usually seen on the left side of the trachea. This is due to the close contact of the aortic arch as it passes backwards against this part of the tube. Except at its lower end, which is very slightly inclined to the right, the trachea adheres rigorously to the mesial plane.

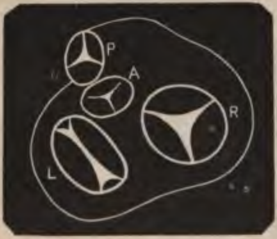

FIG. 42.—Diagram of the Base of the Ventricular Portion of the Heart.

P. Pulmonary opening
A. Aortic opening.
L. Left auriculo-ventricular opening.
R. Right auriculo-ventricular opening.

The relations of the thoracic part of the trachea are as follows :—*In front*—(1) the manubrium sterni, to the posterior aspect of which the sterno-hyoid and sterno-thyroid muscles are attached; (2) the remains of the thymus body; (3) the left innominate vein; (4) the aortic arch and the origins of the innominate and left common carotid arteries; (5) the deep cardiac plexus. *Behind*, it rests upon the œsophagus, which lies somewhat to the left side of the mesial plane. On its *right side* are the pleura and the right pneumogastric nerve, and at a higher level the innominate artery; and on its *left side* are the aortic arch, the left recurrent laryngeal nerve, and the left subclavian artery (Figs. 38 and 40).

Bronchi. — The two bronchi proceed downwards and outwards from the termination of the trachea — each towards the hilum of the corresponding lung. Like the trachea, they are kept permanently patent by the presence of cartilaginous rings in their walls. These rings are deficient posteriorly, so that each bronchus exhibits a flattened posterior surface similar to that of the trachea. The two bronchi differ from each other in length, width, and in the direction which they pursue, as well as in the relations which they present.

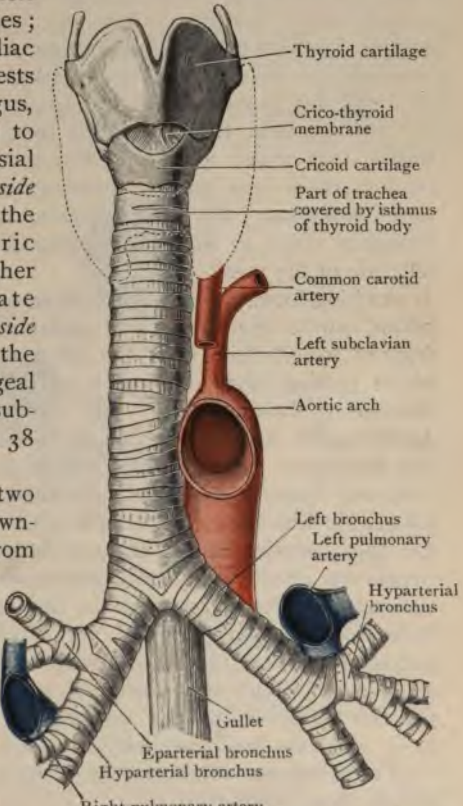
Thyroid cartilage
Crico-thyroid membrane
Cricoid cartilage
Part of trachea covered by isthmus of thyroid body
Common carotid artery
Left subclavian artery
Aortic arch
Left bronchus
Left pulmonary artery
Hyparterial bronchus
Gullet
Eparterial bronchus
Hyparterial bronchus
Right pulmonary artery

FIG. 43.—The Trachea and Bronchi. The dotted line gives the outline of the thyroid body.

The first collateral branch arises from the right bronchus much nearer the trachea than in the case of the left bronchus. Taking the origin of this branch as indicating the terminal limit of each of these tubes, the left bronchus is at least twice as long as the right bronchus. On the other hand, the right bronchus is wider than the left, and this is clearly due to the greater size of the right lung. In so far as the direction which they pursue is concerned, it will be noticed that the right bronchus takes a more vertical course than the left bronchus. It therefore lies more in a line with the trachea, and it is owing to this, as well as its greater width, that when foreign bodies are introduced into the trachea there is a greater tendency for them to enter the right bronchus. The more horizontal course of the left bronchus is due to the marked projection of the heart to the left side of the mesial plane.

Arching forwards over the *right bronchus* is the vena azygos major, whilst the vena cava superior passes downwards in front of it. Arching over the *left bronchus* is the aortic arch, whilst passing down behind it are the œsophagus and the descending thoracic aorta. On each side, as the pulmonary artery passes outwards, it crosses in front of the corresponding bronchus: on the right side it is placed below the first collateral branch (eparterial bronchus), on the left side it lies above the first collateral branch (first hyparterial bronchus). On the posterior aspect of each bronchus the vagus nerve breaks up into the posterior pulmonary plexus. Occupying the angular interval between the bronchi there is a cluster of bronchial lymphatic glands, and a chain of these glands accompanies each tube towards the lung.

A small fleshy slip passing from the posterior aspect of the left bronchus to the œsophagus is frequently present. It is called the *broncho-œsophageal muscle.*

The relations of the bronchi in the roots of the lungs have already been studied (p. 32).

Posterior Mediastinum.—This term is applied to that part of the interpleural space which lies behind the pericardium. It may be regarded as a continuation downwards of the posterior part of the superior mediastinum, and many of the structures in the one are prolonged downwards into the other. The arbitrary upper limit of the posterior mediastinum is the lower border of the fourth dorsal vertebra. *In front*, it is bounded by the pericardium, except in its very lowest portion, where the anterior wall is formed by the posterior surface of the diaphragm (Fig. 45). *Behind*, it is limited by the bodies of the dorsal vertebræ below the fourth, and *on each side* by the mediastinal pleura as it passes back from the pericardium to the spine. In transverse section its outline is quadrilateral. Figs. 44 and 45 are taken from tracings of transverse sections through the space. They serve to show the character of the space and the relative positions of some of the more important contents. The following is a list of the structures which it contains:—

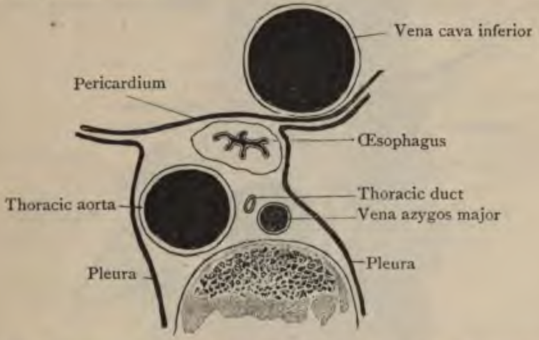

FIG. 44.—Tracing of section through the Posterior Mediastinum at the level of the eighth dorsal vertebra.

1. The descending thoracic aorta.
2. The œsophagus.
3. The pneumogastric nerves.
4. The thoracic duct.
5. The vena azygos major.
6. Certain of the right aortic intercostal arteries.
7. The vena azygos minor superior.
8. The vena azygos minor inferior.
9. The great splanchnic nerves.
10. Some lymphatic glands.

Dissection.—To open into the posterior mediastinal space it is necessary to make a vertical incision through the pericardium, which forms its anterior wall. Carry the knife along the line of the œsophagus, and throw the pericardium outwards. If this be done with care, a fleshy band may, in some cases, be observed crossing the superficial aspect of the thoracic aorta, and extending from the œsophagus to the pleura, which forms the left lateral wall of the posterior mediastinal space. This is the *pleuro-œsophageal muscle*. In the majority of cases, however, this muscle is only represented by a few slender muscular fasciculi, which are difficult to isolate from the areolar tissue in which they lie.

Pneumogastric Nerves (nervi vagi).—The pneumogastric nerves can now be followed throughout their entire course within the thorax. They traverse both the superior and posterior mediastinal spaces, but differ so much in their relations on the two sides of the body that it is best to examine each separately.

The *left pneumogastric nerve* enters the thorax in the interval between the left common carotid and left subclavian arteries, and behind the left innominate vein (Fig. 40, p. 71). It has already been observed crossing the arch of the aorta behind and to the left side of the phrenic nerve and the two superficial cardiac nerves (Fig. 38, p. 68). Here also it has been seen to give off its recurrent laryngeal branch. Leaving the aorta, it sinks behind the root of the left lung (Fig. 39, p. 69), and at once breaks up into a number of branches, which unite in a plexiform manner to form the *left posterior pulmonary plexus.* It issues from this plexus in the form of one or two cords, which pass to the anterior aspect of the œsophagus. Upon the œsophagus another plexus—the *plexus gulæ*—is formed. Both of the pneumogastric nerves take part in the formation of this plexus. From the plexus gulæ the left pneumogastric emerges as one trunk, and passes out of the thorax by the œsophageal opening of the diaphragm. Within the abdomen it breaks up into branches upon the anterior surface of the stomach.

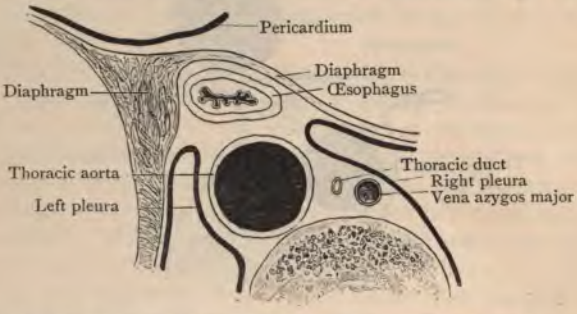

FIG. 45.—Tracing of a section through the lower part of the Posterior Mediastinum, where its anterior wall is formed by the diaphragm.

The *right pneumogastric nerve*, in the upper part of the superior mediastinum, lies deeper in the thorax than the left nerve. It enters by passing between the subclavian artery and the right innominate vein, and descends by the side of the trachea (Figs. 40 and 38) to the posterior aspect of the root of the right lung (Fig. 39, p. 69). Here it breaks up into the *right posterior pulmonary plexus*, and, issuing from this in the form of two nerve cords, it takes part in the formation of the *plexus gulæ*. It leaves this plexus upon the posterior aspect of the œsophagus, and, entering the abdomen through the œsophageal opening of the diaphragm, it breaks up into branches on the posterior aspect of the stomach.

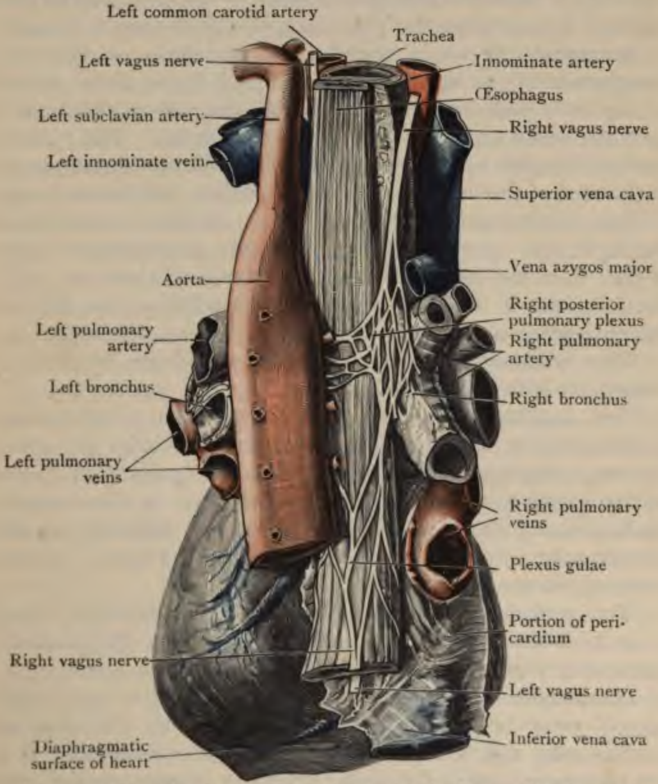
Left common carotid artery
Trachea
Left vagus nerve
Innominate artery
Œsophagus
Left subclavian artery
Right vagus nerve
Left innominate vein
Superior vena cava
Aorta
Vena azygos major
Right posterior pulmonary plexus
Left pulmonary artery
Right pulmonary artery
Left bronchus
Right bronchus
Left pulmonary veins
Right pulmonary veins
Plexus gulae
Portion of pericardium
Right vagus nerve
Left vagus nerve
Inferior vena cava
Diaphragmatic surface of heart

FIG. 46.—Posterior Aspect of the Heart with the Descending Aorta, the Trachea and Bronchi, and the Œsophagus.

The pneumogastric nerves give off the following branches within the thorax:—

1. Recurrent laryngeal (left side).
2. Thoracic cardiac (right side).
3. Pulmonary.
4. Œsophageal.
5. Pericardial.

The *left recurrent laryngeal nerve* (nervus laryngeus inferior sinister) springs from the pneumogastric as it crosses the arch of the aorta. It hooks round the aortic arch, or rather the attachment of the ligamentum arteriosum to the under surface of the arch, and reaching the trachea, ascends in the interval between this and the œsophagus to the larynx. The *right recurrent laryngeal nerve* (nervus laryngeus inferior dexter) arises in the root of the neck, and hooks round the subclavian artery.

The *thoracic cardiac branches* (rami cardiaci inferiores) of the right side proceed in part from the pneumogastric and in part from the recurrent laryngeal nerve of that side. On the left side of the body they are derived from the left recurrent laryngeal nerve as it turns round the aortic arch.

The *pulmonary branches* have already been studied in connexion with the root of the lung (pp. 31, 32).

The *œsophageal branches* (rami œsophagei) are dispensed to the gullet in two sets—(1) a few delicate twigs are given by the pneumogastric before it enters the pulmonary plexus to that portion of the œsophagus which lies in the superior mediastinum; (2) numerous filaments are supplied by the plexus gulæ to that part of the œsophagus which is placed in the posterior mediastinum.

The *pericardial branches* are a few fine filaments which come from the plexus gulæ and, perhaps, from the posterior pulmonary plexus and enter the back of the pericardium.

Œsophagus.—The thoracic portion of the œsophagus should next be studied. It lies partly in the superior mediastinum and partly in the posterior mediastinum. It is the narrowest, but at the same time the most muscular, part of the alimentary canal. It descends in front of the spine, following its antero-posterior curvature, and leaves the thoracic cavity opposite the tenth dorsal vertebra by passing through the œsophageal opening of the diaphragm. The œsophagus does not pursue a straight course through the thorax: it enters somewhat to the left of the middle line; but on tracing it downwards, it will be noticed to incline inwards, so as to assume a mesial position opposite the fifth dorsal vertebra.

From this it again deviates to the left so as to gain the œsophageal opening in the diaphragm.

In the superior mediastinum the œsophagus lies immediately behind the trachea (Figs. 40 and 38); below this, it is crossed by the left bronchus, with which it is sometimes connected by the broncho-œsophageal muscle (Fig. 39). From this point onwards through the posterior mediastinum it is covered in front by the pericardium, which is applied closely to it (Fig. 44). Just before entering the abdomen it lies behind the posterior part of the diaphragm (Fig. 45). From above downwards, therefore, the immediate anterior relations of the œsophagus are: (1) trachea; (2) left bronchus; (3) pericardium; (4) diaphragm. *Behind*, the gullet lies, except at its lower end, in front of the vertebral column, but there are many structures which intervene between them. Thus, in the superior mediastinum the longus colli muscle separates the gullet from the spine, while in the posterior mediastinum it is placed in front of the vena azygos major and the thoracic duct. The vena azygos minor inferior and superior and the right intercostal arteries also cross behind it. In its lower part, the gullet inclines forwards and to the left, so that it comes to rest directly upon the anterior surface of the thoracic aorta. These relations are seen in Figs. 44 and 45. Upon the *right side*, during its course through the posterior mediastinum, the œsophagus is clothed by the mediastinal pleura, whilst on the *left side* it is related in the posterior mediastinum to the thoracic aorta, except where in its lower part it lies in front of that vessel (Fig. 45). In the superior mediastinum the thoracic duct is closely applied to the left side of the œsophagus, and the left pleura comes into relationship with it (Fig. 40, p. 71). Below this, however, except immediately above the point where it pierces the diaphragm, it is not directly related to the pleura of the left side.

The pneumogastric nerves form the plexus gulæ on the walls of the gullet, as it traverses the posterior mediastinum, and accompany it in the form of two nerve-trunks through the œsophageal opening—the right nerve being placed on its posterior aspect, whilst the left nerve is placed in front of it.

Descending Thoracic Aorta (aorta thoracica).—The descending thoracic aorta is the direct continuation of the aortic arch, and it traverses the posterior mediastinum. It begins at the lower border of the fourth dorsal vertebra, and ends opposite the last dorsal vertebra by entering the abdomen through the aortic opening of the diaphragm, and becoming the abdominal aorta. At its commencement it lies somewhat to the left of the middle line, but as it proceeds downwards it inclines inwards, so that at its termination it is mesial in position. It lies upon the bodies of the vertebræ, and therefore it shows a curve corresponding to that of the vertebral column in the dorsal region. *In front*, it is crossed by the root of the left lung. Below this, it is covered by the pericardium and the posterior part of the diaphragm. *Behind*, it rests upon the vertebral bodies and the intervening intervertebral discs, whilst crossing behind it the dissector will observe the vena azygos minor inferior, and, in many cases, the vena azygos minor superior. To *the left side*, and closely applied to the vessel, is that part of the pleura which forms the left lateral wall of the posterior mediastinum; whilst on its *right side* will be noticed the thoracic duct and the vena azygos major.

The œsophagus presents important relationships to the thoracic aorta. At first it lies to the *right* of the aorta, but as it approaches the diaphragm it inclines to the left, and comes to lie *in front* of the vessel; and lastly, before it passes through the œsophageal opening of the diaphragm, it is somewhat to its *left side* and still distinctly in front.

The **Branches of the Descending Thoracic Aorta** may be grouped under the heads of *visceral* and *parietal*.

Visceral.	Bronchial.
	Pericardial.
	Œsophageal.
	Posterior mediastinal.
Parietal.	Intercostal (nine on each side).
	Subcostal.

The *bronchial arteries* (arteriæ bronchiales) are usually three in number—*two* for the left lung and *one* for the right lung. They are very variable in their manner of origin. The *right bronchial artery* often springs from the first right aortic intercostal artery. The *left bronchial arteries* generally take origin from the aorta. They run upon the posterior aspect of the corresponding bronchus, and they have already been studied as constituent parts of the roots of the lungs. In the substance of the lung, they follow the bronchi, and show a similar mode of branching and distribution.

The *bronchial veins* are of small size. The *left* opens into the vena azygos minor superior; the *right* joins the vena azygos major.

The *pericardial branches* (rami pericardiaci) are some minute twigs which are distributed to the posterior aspect of the pericardium.

The *œsophageal arteries* (arteriæ œsophageæ) are the vessels of supply to the gullet. They are four or five in number, and are irregularly placed. They spring from the front or right side of the aorta, and form a chain of anastomosing branches on the wall of the œsophagus. Above, this chain communicates with branches of the inferior thyroid artery, whilst below, it communicates with the ascending œsophageal branches of the coronary artery of the stomach.

The *posterior mediastinal branches* (rami mediastinales) are very small, and are given to the areolar tissue and glands in the posterior mediastinal space.

The *intercostal branches* (arteriæ intercostales) will be observed arising in pairs from the posterior aspect of the aorta. Defer their examination until the thoracic duct and the sympathetic cords have been dissected. The pair of *subcostal arteries* lie in series with the intercostal branches, and may be studied along with them.

Thoracic Duct (ductus thoracicus).—The thoracic duct, although a vessel of small calibre, is one of high importance. It receives all the lymphatic vessels of the body below the diaphragm (except those from part of the upper surface of the liver), the lymphatics of the left side of the chest (including the left lung and left side of the heart), and the lymphatics of the left superior extremity and left side of the head and neck. It will be found by dissecting in the loose areolar tissue which lies between the aorta and the vena azygos major, and it will be recognised from its position, and by the great elasticity which it exhibits when it is pulled by the forceps. Trace it downwards, and it will be found to enter the thorax upon the right side of the aorta, and through the same opening in the diaphragm. It commences within the abdomen upon the bodies of the first and second lumbar vertebræ as an elongated dilatation, called the *receptaculum chyli*. At the level of the fifth dorsal vertebra it passes from the right to the left of the mesial plane by crossing behind the œsophagus (Fig. 39, p. 69). It now ascends into the neck between the œsophagus and left pleura, and arching

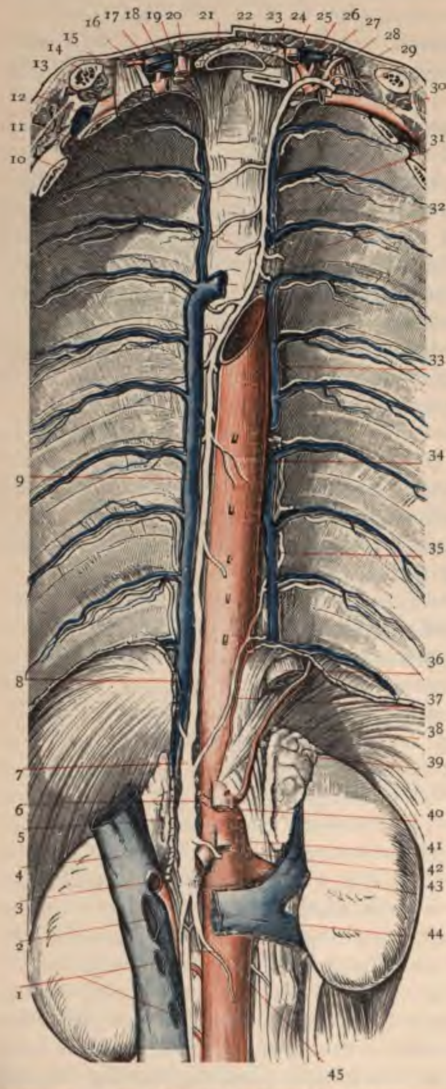

FIG. 47.—The Thoracic Duct and its Tributaries.

1. Lumbar veins.
2. Left renal vein.
3. Right renal artery.
4. Inferior vena cava.
5. Suprarenal body.
6. Receptaculum chyli.
7. Thoracic duct.
8. Descending thoracic lymphatic trunk.
9. Vena azygos major.
10. Mediastinal lymphatic vessel.
11. Superior intercostal vein.
12. Subclavian vein.
13. Subclavian artery.
14. Clavicle.
15. Scalenus anticus muscle.
16. Phrenic nerve.
17. Thyroid axis.
18. Internal jugular vein.
19. Vertebral artery.
20. Common carotid artery.
21. Trachea.
22. Thyroid body.
23. Œsophagus.
24. Common carotid artery.
25. Internal jugular vein.
26. Vertebral artery.
27. Thyroid axis.
28. Common lymphatic trunk from head and upper limb.
29. Scalenus anticus muscle.
30. Subclavian artery.
31. Superior intercostal vein.
32. Bronchial lymphatic vessel.
33. Vena azygos minor superior.
34. Aorta.
35. Vena azygos minor inferior.
36. Œsophagus.
37. Descending thoracic lymphatic trunk.
38. Inferior phrenic artery.
39. Suprarenal body.
40. Cœliac axis.
41. Superior mesenteric artery.
42. Common intestinal lymphatic trunk.
43. Renal artery.
44. Renal vein.
45. Common lumbar lymphatic trunk.

outwards it ends by joining the internal jugular vein at its point of union with the subclavian vein. In the diagrams which are given of the posterior and superior mediastinal spaces, the relations of the thoracic duct may be studied (Figs. 44, p. 81; 39, p. 69; 38, p. 68; 40, p. 71). It will be seen that in the posterior mediastinum it lies behind the œsophagus, but in the superior mediastinum it is placed upon the left side of the œsophagus. In the former situation, before the parts are disturbed by dissection, it can readily be exposed by raising the *right lung* and dividing the right mediastinal pleura; in the latter situation the *left lung* must be raised and the left mediastinal pleura divided. As it passes upwards through the thorax, the thoracic duct pursues a somewhat wavy or flexuous course. It frequently breaks up into two or more branches, which unite again to form a single trunk. It is provided at intervals with valves of two segments, and these, when the duct is injected, give it a beaded or nodulated appearance. The valves are more especially numerous in the upper part of the duct.

Thoracic Lymphatic Glands.—Throughout the dissection of the thorax the dissector has, from time to time, met with groups of lymphatic glands. These are of considerable importance, seeing that their enlargement in disease is not infrequently the cause of serious thoracic trouble. The following are the chief groups:—(1) Two chains of minute glands, which are placed in relation to the anterior thoracic wall and follow the course of the internal mammary vessels. They are termed *sternal glands* (lymphoglandulæ sternales), and are joined by lymphatic vessels from the anterior thoracic wall, the mammary glands, the front part of the diaphragm, and the upper part of the front wall of the abdomen. (2) Two chains of glands on the posterior thoracic wall—one on either side of the spine in relation to the vertebral extremities of the ribs. They are very minute, and offsets from these chains accompany the intercostal vessels between the intercostal muscles. They are therefore called the *intercostal glands* (lymphoglandulæ intercostales), and they receive the lymphatics of the posterior thoracic wall. (3) *Anterior mediastinal glands* (lymphoglandulæ mediastinales anteriores), two or three in number, which receive lymphatics from the diaphragm and upper surface of the liver. They occupy the lower open part of the anterior mediastinum. (4) *Posterior mediastinal glands* (lymphoglandulæ mediastinales posteriores), which follow the course of the thoracic aorta, and are joined by lymphatics from the diaphragm, pericardium, and œsophagus. (5) *Superior mediastinal glands* (lymphoglandulæ mediastinales superiores), an important group, eight to ten in number, and placed in relation to the aortic arch. The lymphatics of the heart, pericardium, and thymus body enter these. (6) *Bronchial glands* (lymphoglandulæ bronchiales), continuous above with the preceding, and massed chiefly in the interval between the two bronchi. They are also prolonged into the roots of the lungs. The lymphatic vessels of the lungs pour their contents into them. In the adult, they are generally dark in colour, and sometimes as black as ink.

The lymphatics of the right side of the chest, the right lung, and the right half of the heart join the *right lymphatic duct* (ductus lymphaticus dexter), a minute and short vessel situated in the root of the neck. It opens into the angle of union between the right internal jugular and right subclavian veins.

Removal of the Lungs.—The lungs may now be removed by dividing the trachea about an inch and a half above its bifurcation. The bronchi and vessels should be traced into the lobes of the lungs, and their manner of subdivision and distribution throughout its substance studied.

Ramification of the Bronchi and Vessels within the Lungs.—The student has previously observed that the two lungs are not symmetrical. The right lung is subdivided into three lobes, whilst the left lung is cleft into two lobes. The bronchi exhibit a corresponding want of symmetry. Each tube, as it approaches the pulmonary hilum, gives off branches for the different lobes. The *right bronchus* sends off two such branches for the upper and middle lobes of the right lung respectively, whilst the main stem of the tube sinks into the inferior lobe. The *left bronchus* sends off a large branch to the upper lobe of the left lung, and then enters the lower lobe. The first branch of the right bronchus leaves the main stem about one inch from the trachea. The first branch of the left bronchus, on the other hand, takes origin about twice that distance from the trachea.

The relation of the pulmonary artery to the bronchial subdivisions is different on the two sides. In both cases it lies in front of the undivided portion of the tube, but on the right side it turns backwards, so as to reach the posterior aspect of the bronchus below the first and above the second division. It is due to this arrangement that the right bronchus occupies the highest level in the right pulmonary root. On the left side, the pulmonary artery turns backwards above the level of the first bronchial branch, and therefore holds the highest place in the left pulmonary root. On the right side, then, the first bronchial branch is placed above the pulmonary artery, and it is termed the *eparterial bronchus*; all the others lie below it, and are termed *hyparterial bronchi*. On the left side there is *no eparterial* tube; they are all *hyparterial*.

When the main stem of the bronchus is followed into the inferior lobe on either side, it will be observed to travel downwards towards the back part of the base, and give off, as it proceeds, a series of *ventral*, and a series of smaller *dorsal* branches. The first hyparterial division on each side (*i.e.* the branch to the middle lobe of the right side, and the branch to the upper lobe of the left side) may be regarded as the first member of the ventral group (Fig. 48).

It should be observed that when the bronchial tubes enter the lung, they cease to be flattened posteriorly, and become uniformly cylindrical. This is due to the cartilage being disposed around the tube on all its aspects, in the form of irregular flakes, and imperfect rings. The farther the tubes are traced, the scarcer and finer become the particles of cartilage.

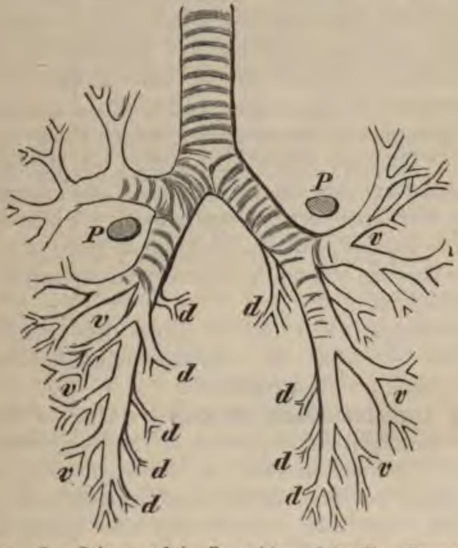

FIG. 48.—Schema of the Branching of the Two Bronchi. (From Gegenbaur.)

P. Pulmonary artery; *d.* Dorsal divisions of the bronchi; *v.* Ventral divisions of the bronchi. The highest *v* on each side indicates the first hyparterial bronchus, or, in other words, the branch to the upper lobe of the left lung and the middle lobe on the right lung.

The *pulmonary vessels* in the substance of the lungs run with the bronchi. The *veins* still keep to the front of the air-passages; the *arteries*, however, as we have noted, turn backwards to reach their posterior aspect, and this relation they maintain in the lung substance.

Dissection.—The dissector should next turn his attention to the thoracic portion of the sympathetic nervous system. In order to expose it, he must strip the parietal pleura from the sides of the vertebræ and the inner surface of the ribs.

Gangliated Cord of the Sympathetic (pars thoracicalis nervi sympathici).—This extends downwards through the thoracic cavity upon the heads of the ribs and the intervening intercostal spaces, and has an appearance somewhat similar to that of a knotted string. The thoracic ganglia are usually eleven in number. For the most part these lie on the heads of the ribs, but the first is placed over the inner part of the first intercostal space. Towards the diaphragm the cord inclines forward, so that one or two of the lower ganglia come to lie upon the bodies of the dorsal vertebræ. The first ganglion is considerably larger than those which succeed it. They are all linked together by intervening nerve cords. Superiorly, the thoracic part of the sympathetic is continuous with the cervical sympathetic; whilst inferiorly it becomes continuous with the abdominal portion of the sympathetic by passing behind the ligamentum arcuatum internum of the diaphragm.

The branches which spring from the ganglia may be divided into two sets: (*a*) central communicating and (*b*) peripheral branches of distribution.

Central Communicating Branches.—One of the leading characters of the thoracic portion of the sympathetic cord is the intimate manner in which it is brought into connection with the spinal nerves. *White rami communicantes* pass from each of the intercostal nerves into the sympathetic cord. They become connected either with the ganglia or with the intervening portions of the cord. *Grey rami communicantes*, on the other hand, arise from each ganglion, somewhat irregularly, and convey fibres to the various intercostal nerves.

Peripheral Branches of Distribution.—These take origin irregularly, and are (1) pulmonary, (2) aortic, and (3) the three splanchnic nerves.

The *pulmonary branches* spring from the second, third, and fourth ganglia, and join the posterior pulmonary plexus. The *aortic branches* are fine filaments which arise from the upper five ganglia and proceed to the coats of the thoracic aorta.

The *splanchnic nerves* are three in number, and are distinguished by the terms, *great*, *small*, and *smallest*, and they are destined for the supply of abdominal viscera.

The *great splanchnic nerve* (nervus splanchnicus major) is formed by the union of five roots derived from the sixth, seventh, eighth, ninth, and tenth ganglia. This description, however, must be regarded as being somewhat arbitrary, as there is a considerable amount of variability in the number and manner of origin of the roots of this nerve. The great splanchnic has more the appearance of a cerebro-spinal nerve than a sympathetic nerve, owing to the large number of spinal nerve-fibres which it contains. It passes downwards upon the bodies of the vertebræ, and leaves the thorax by piercing the crus of the diaphragm. Within the abdomen it ends by joining the upper part of the semilunar ganglion.

Upon the last dorsal vertebra, a ganglion called the *splanchnic ganglion* will in all probability be found in connection with the great splanchnic nerve. This ganglion is usually of small size, involving only a very few of the anterior fibres of the nerve. Sometimes, however, it forms a distinct oval bulging on the nerve-trunk. A few slender filaments are given by the ganglion to the coats of the aorta, and these in some cases may be made out to communicate across the middle line of the body with the corresponding branches of the ganglion of the opposite side.

The *small splanchnic nerve* (nervus splanchnicus minor) arises by two roots from the ninth and tenth or from the tenth and eleventh thoracic ganglia. It enters the abdomen by piercing the crus of the diaphragm, and it ends by joining the lower part of the semilunar ganglion.

The *smallest splanchnic nerve* (nervus splanchnicus imus) is a minute twig which takes origin from the lowest thoracic ganglion. It pierces the diaphragm, and ends in the renal plexus. It is often absent, and then its place is taken by one or more filaments from the small splanchnic nerve.

To obtain a proper view of this minute nerve, the diaphragm should be divided over its course, but this can only be done in cases where the dissector of the abdomen has completed his examination of the diaphragm.

Thoracic Wall.—The thoracic wall should now be studied from within. Certain facts which have previously been stated regarding it can now be verified (p. 4). The *internal intercostal muscle*, in each space, will be seen to extend backwards as far as the angles of the ribs. At this point it stops abruptly, but the external intercostal muscle is not exposed to view. It is covered on its deep aspect by the posterior intercostal membrane, the connexions of which can now be ascertained.

The *posterior intercostal membrane* is a strong aponeurotic layer which is continuous internally with the outer margin of the superior costo-transverse ligament, and extends outwards upon the deep surface of the external intercostal muscle. At the inner margin of the internal intercostal muscle it passes between the two intercostal muscular strata and is gradually lost. The intercostal vessels and nerve extend outwards upon its anterior aspect under cover of the pleura.

The *subcostal muscles* are also displayed. They are small fleshy fasciculi placed upon the ribs, internal to their angles. The muscular fibres which compose them have the same direction as the internal intercostal muscles. They extend over one or, in many cases, two intercostal spaces.

Dissection.—Remove the posterior intercostal membrane from one or two of the spaces, and the subjacent *external intercostal muscles* will be brought into view. These muscles reach backwards as far as the tubercles of the ribs.

Intercostal Arteries.—The *aortic intercostal arteries* have already been seen taking origin from the thoracic aorta. One is given to each of the nine lower intercostal spaces upon both sides of the body. As the aorta lies somewhat to the left of the middle line, the right aortic intercostal arteries are longer than those of the left side. In both cases they run outwards over the bodies of the vertebræ, and under cover of the gangliated cord of the sympathetic. On the right side, the arteries also pass under cover of the œsophagus, the thoracic duct, and the vena azygos major. As they leave the vertebral column to enter the intercostal spaces, each of the vessels gives off a large *dorsal branch* which passes backwards in the interval between the transverse processes and is distributed to the muscles and skin of the back. From this branch a *spinal twig* is supplied through the intervertebral foramen to the spinal cord and its membranes. In each space, the intercostal artery proceeds outwards, first lying between the posterior intercostal membrane and the pleura, and afterwards between the two muscular strata. Each artery is accompanied by a nerve and a vein. The vein usually occupies the *highest* level, the nerve the *lowest* level, whilst the artery is *intermediate*. The distribution of these vessels in the thoracic parietes has already been studied (p. 6).

The position of the intercostal artery in the intercostal

space is a matter of some surgical importance. At first it crosses the intercostal space obliquely, so as to gain the shelter of the subcostal groove of the rib which bounds the space above. It attains this position near the angle of the rib, and as it proceeds forwards the groove affords it a very efficient protection against wounds from without.

The intercostal arteries which supply the *two highest* intercostal spaces are derived from the *superior intercostal branch* of the subclavian artery. The superior intercostal artery descends upon the necks of the first two ribs, and external to the gangliated cord. It anastomoses with the first aortic intercostal artery, and sends outwards two vessels for the two highest spaces. Each of these, in turn, gives off a *dorsal branch* similar to the dorsal branches of the aortic intercostal arteries.

Subcostal Arteries.—These arteries form a pair of vessels in series with the intercostal arteries. They enter the abdomen by passing under the ligamentum arcuatum externum, and run in company with the last dorsal nerves along the lower borders of the last pair of ribs.

Intercostal Nerves.—The intercostal nerves pass outwards in company with the arteries. The connecting twigs which pass between these nerves and the sympathetic ganglia have already been noted. Each nerve lies at a lower level than the corresponding artery, and is at first placed between the posterior intercostal membrane and the pleura, and then between the two muscular strata. The further course of these nerves is described at p. 5.

The *first dorsal nerve* will be found passing upwards over the neck of the first rib to join the brachial plexus. It gives a small branch to the first intercostal space, but this nerve, although it is disposed after the manner of an intercostal nerve, does not furnish, as a rule, a lateral cutaneous or an anterior branch. The *second dorsal* or *intercostal nerve*, as a rule, sends a branch upwards over the neck of the second rib to join that portion of the first dorsal nerve which enters the brachial plexus. This communicating twig is usually minute and insignificant, but sometimes it is a large nerve; and, in these cases, the intercosto-humeral nerve, or lateral cutaneous branch of the second intercostal nerve, is very small or altogether absent.

Veins of the Thoracic Wall.—When the dissector has

traced the *intercostal veins* to their various destinations, he will find that they differ in their arrangement upon the two sides of the body. On the *right side* they terminate in three different ways :—

1. The intercostal vein of the first or highest space joins the *right innominate vein* (sometimes the *vertebral vein*).
2. The intercostal veins of the second and third spaces (and sometimes of the fourth space) unite into a common trunk, which joins the upper part of the *vena azygos major*. The common trunk is termed the *superior intercostal vein*.
3. The intercostal veins of the eight lower spaces join the *vena azygos major*.

On the *left side* of the body *four* modes of termination may be recognised :—

1. The intercostal vein of the first or highest space has the same termination as the corresponding vein of the right side. It joins the *left innominate vein* (sometimes the *vertebral vein* of its own side).
2. The intercostal veins of the second and third spaces (and sometimes of the fourth space) converge, and by their union form a single trunk, termed the *superior intercostal vein*, which crosses the arch of the aorta and joins the *left innominate vein* independently of the first intercostal vein.
3. The intercostal veins of the fourth, fifth, sixth, seventh, and eighth spaces terminate in the *vena azygos minor superior*.
4. The intercostal veins of the ninth, tenth, and eleventh spaces join the *vena azygos minor inferior*.

The azygos veins which thus receive the blood of the great majority of the intercostal veins should now be studied.

Vena Azygos Major (vena azygos).—This vein takes origin within the abdomen in the *right ascending lumbar vein* (vena lumbalis ascendens), a vessel which links together certain of the lumbar veins, and sometimes presents a direct communication with the common iliac vein. It enters the thorax through the aortic opening of the diaphragm, lying upon the right side of the thoracic duct and the aorta. In the thorax it extends upwards upon the bodies of the dorsal vertebræ and over the right intercostal arteries, until it reaches the level of the upper border of the root of the right lung. At this point it hooks forwards over the right bronchus, and ends by joining the superior vena cava. It is situated in the posterior mediastinum, with the aorta and thoracic duct lying to the left (Fig. 47, p. 88).

The *tributaries* of the vena azygos major are as follows :— (1) the superior intercostal vein of the right side; (2) the intercostal veins of the eight lower spaces of the right side;

(3) the vena azygos minor superior; (4) the vena azygos minor inferior; (5) the bronchial veins from the right lung; (6) certain of the œsophageal veins; (7) some minute pericardiac veins.

The vena azygos major communicates below with some of the lumbar veins—tributaries of the inferior vena cava; whilst above, it pours its blood into the superior vena cava. In this way it forms a link by which the superior vena cava is brought into connection with the inferior vena cava.

Vena Azygos Minor Superior (vena hemiazygos accessoria).—This vein is formed on the left side of the body by the union of the intercostal veins of the fourth, fifth, sixth, seventh, and eighth spaces. It communicates above with the left superior intercostal vein, which carries the blood from the second and third intercostal spaces to the left innominate vein. At the level of the eighth dorsal vertebra it turns inwards behind the aorta and thoracic duct, and crossing the middle line ends by joining the vena azygos major. In many cases, however, it joins the vena azygos minor inferior. In addition to the intercostal veins it receives the left bronchial veins.

Vena Azygos Minor Inferior (vena hemiazygos).—This vein takes origin within the abdomen as the *left ascending lumbar vein.* It enters the thorax by piercing the left crus of the diaphragm, and is continued upwards upon the vertebral column as far as the ninth dorsal vertebra. At this point it turns to the right, and crossing behind the aorta and the thoracic duct, it joins the vena azygos major independently of the vena azygos minor superior.

The tributaries of this vein are the intercostal veins of the three lower spaces of the left side.

The veins of the thoracic parietes are extremely variable, and the above description of them must be looked upon as merely representing their more usual arrangement.

THORACIC JOINTS.

The student should now complete the dissection of the thorax by an examination of the various thoracic joints.

Dissection.—The portion of the sternum with the cartilages of the ribs which was laid aside, together with the other joints in connection with the anterior wall of the thorax, should now be dissected. Inter-sternal, costo-

sternal, and inter-chondral articulations require examination. Very little dissection is necessary. After the ligaments have been defined, the dissector should remove a thin slice from the anterior aspect of each articulation, in order that the interior of the joint may be displayed.

Manubrio-gladiolar Articulation.—This joint, between the manubrium and the gladiolus of the sternum, partakes of the nature of an amphiarthrosis. The opposing surfaces of bone are covered by a layer of hyaline cartilage, and are united by intermediate fibro-cartilage. The joint is supported by some anterior and posterior longitudinal fibres which are developed in connection with the strong and thick periosteum. The posterior ligament is the stronger of the two.

Sterno-chondral Articulations.—Seven ribs articulate, by means of their cartilages, directly with each side of the sternum. The articulations of the first and the sixth are peculiar, inasmuch as they articulate with single pieces of the sternum, viz., with the manubrium and the lowest piece of the gladiolus respectively, whereas each of the cartilages of the other true ribs articulates with two segments of the sternum. The cartilage of the first rib is implanted upon the side of the manubrium without any synovial membrane, or other material, intervening. The second costal cartilage is usually separated from the sternum by two synovial membranes, between which an interarticular ligament is developed. In the case of the other joints it is more common to find a single synovial cavity and no interarticular ligament. There is, however, considerable variety in these articulations, and a synovial membrane is very frequently wanting altogether in the sterno-chondral joint of the seventh costal cartilage.

With the exception of the first, and very frequently the seventh, the sterno-chondral joints belong to the diarthrodial variety. They are provided with anterior and posterior ligaments, and also, in those cases where the joint presents a double synovial cavity, with an interarticular ligament.

The *anterior* and *posterior ligaments* (ligamenta sterno-costalia radiata) are strong, flattened bands of fibres which radiate from the extremities of the rib-cartilages, and blend with the periosteum on the anterior and posterior surfaces of the sternum. The *interarticular ligaments* are feeble bands which pass from the tips of the rib-cartilages to the sternum, and divide the articulations in which they exist into an upper and a lower compartment, each lined by a synovial membrane.

artery and the right innominate vein, and descends by the side of the trachea (Figs. 40 and 38) to the posterior aspect of the root of the right lung (Fig. 39, p. 69). Here it breaks up into the *right posterior pulmonary plexus*, and, issuing from this in the form of two nerve cords, it takes part in the formation of the *plexus gulæ*. It leaves this plexus upon the posterior aspect of the œsophagus, and, entering the abdomen through the œsophageal opening of the diaphragm, it breaks up into branches on the posterior aspect of the stomach.

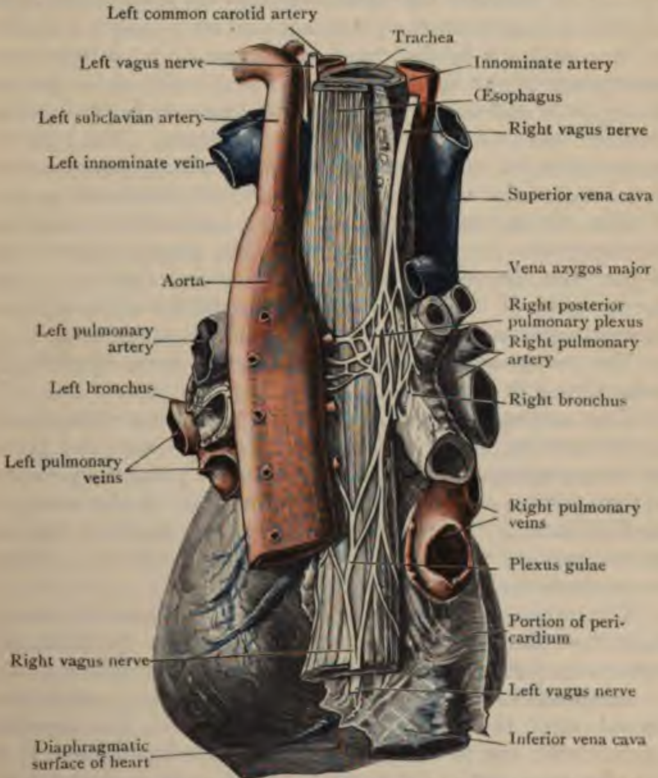
Left common carotid artery
Trachea
Left vagus nerve
Innominate artery
Œsophagus
Left subclavian artery
Right vagus nerve
Left innominate vein
Superior vena cava
Aorta
Vena azygos major
Right posterior pulmonary plexus
Left pulmonary artery
Right pulmonary artery
Left bronchus
Right bronchus
Left pulmonary veins
Right pulmonary veins
Plexus gulae
Portion of pericardium
Right vagus nerve
Left vagus nerve
Inferior vena cava
Diaphragmatic surface of heart

FIG. 46.—Posterior Aspect of the Heart with the Descending Aorta, the Trachea and Bronchi, and the Œsophagus.

The pneumogastric nerves give off the following branches within the thorax :—

But the vertebral extremities of the ribs present another series of articulations. The upper ten ribs, by means of their tubercles, rest upon and articulate with the extremities of the transverse processes of the corresponding dorsal vertebræ. These joints are termed the *costo-transverse articulations* (articulationes costo-transversariæ). The eleventh and twelfth ribs have no tubercles, and do not articulate with the transverse processes of the vertebræ with which they are connected.

Capitular Joints.—These joints belong to the diarthrodial variety, and are provided with—(1) an anterior capitular ligament; (2) an interarticular ligament; and (3) two synovial membranes. In the case of the four ribs, however, which articulate with the body of one vertebra alone (viz., the first, tenth, eleventh, and twelfth), the joint cavity is single.

The *anterior capitular* or *stellate ligament* (ligamentum capituli costæ radiatum) is placed in front of the joint. It is composed of strong fibres, which radiate in a fan-shaped manner from the head of the rib. Its vertebral attachment is effected by three, more or less distinct, slips—(1) the uppermost, which is the largest, passes upwards and inwards to the body of the vertebra, which forms the upper part of the socket for the head of the rib; (2) the middle slip is attached to the intervertebral disc; and (3) the lowest slip goes to the body of the vertebra below the head of the rib. The part of the joint uncovered by the stellate ligament is surrounded by short fibres which form *a capsule*, enclosing the synovial membranes.

In the four joints in which the head of the rib is in contact with the body of one vertebra, the stellate ligament is composed of only two slips. Of these, the *lower* is attached to the body of the vertebra which supports the rib, whilst the *upper* passes upwards to the lower border of the vertebral body immediately above.

Dissection.—The interarticular ligament may be exposed by removing the stellate ligament from the front of the joint.

The *interarticular ligament* of the capitular joints is composed of short strong fibres which are attached, on the one hand, to the ridge between the two articular facets on the head of the rib, and on the other hand to the intervertebral disc. It divides the joint into two synovial cavities, and it is

absent in those cases in which the head of the rib articulates with the body of one vertebra.

The *synovial membranes* are two in number, except in the capitular joints of the first and last three ribs. One is placed above, and the other below the interarticular ligament.

Costo-transverse Articulations.—These are provided with capsular ligaments, and with superior, middle, and posterior costo-transverse ligaments. Each joint cavity is lined by a synovial membrane.

The *superior costo-transverse ligament* (ligamentum costo-transversarium anterius) passes obliquely downwards and inwards from the lower border of the transverse process to the upper border of the neck of the rib next below it. Its internal margin is thick and well defined, and its outer border becomes continuous with the posterior intercostal membrane.

The *interosseous costo-transverse ligament* (ligamentum costo-transversarium posterius) consists of fibrous bands which pass between the neck of the rib and the anterior surface of the transverse process against which it rests.

The fibres of this ligament are so short that it is exceedingly difficult to obtain a proper view of them. The best plan is to saw off, in a horizontal direction, the upper parts of the neck of the rib and the transverse process to which it is attached.

The *posterior costo-transverse ligament* (ligamentum tuberculi costæ) is a strong flattened band which passes, on the posterior aspect of the joint, from the tip of the transverse process to the rough portion of the tubercle of the rib.

The posterior costo-transverse ligament, supplemented by a few fibres which surround the synovial membrane of the joint, forms the *capsular ligament*. When the posterior costo-transverse ligament is removed, the *synovial membrane* is displayed.

Intervertebral Articulations.—The *bodies* of the vertebræ are held together by a series of amphiarthrodial joints, supported in front by an anterior common ligament, and behind by a posterior common ligament. The *neural arches*, by means of the articular processes, form a series of diarthrodial joints surrounded by capsular ligaments, and lined by synovial membranes. Certain ligaments pass between different portions of the neural arches and their processes, viz., the ligamenta subflava between adjacent laminæ, the inter-transverse, the inter-spinous, and the supra-spinous ligaments.

The *posterior intercostal membrane* is a strong aponeurotic layer which is continuous internally with the outer margin of the superior costo-transverse ligament, and extends outwards upon the deep surface of the external intercostal muscle. At the inner margin of the internal intercostal muscle it passes between the two intercostal muscular strata and is gradually lost. The intercostal vessels and nerve extend outwards upon its anterior aspect under cover of the pleura.

The *subcostal muscles* are also displayed. They are small fleshy fasciculi placed upon the ribs, internal to their angles. The muscular fibres which compose them have the same direction as the internal intercostal muscles. They extend over one or, in many cases, two intercostal spaces.

Dissection.—Remove the posterior intercostal membrane from one or two of the spaces, and the subjacent *external intercostal muscles* will be brought into view. These muscles reach backwards as far as the tubercles of the ribs.

Intercostal Arteries.—The *aortic intercostal arteries* have already been seen taking origin from the thoracic aorta. One is given to each of the nine lower intercostal spaces upon both sides of the body. As the aorta lies somewhat to the left of the middle line, the right aortic intercostal arteries are longer than those of the left side. In both cases they run outwards over the bodies of the vertebræ, and under cover of the gangliated cord of the sympathetic. On the right side, the arteries also pass under cover of the œsophagus, the thoracic duct, and the vena azygos major. As they leave the vertebral column to enter the intercostal spaces, each of the vessels gives off a large *dorsal branch* which passes backwards in the interval between the transverse processes and is distributed to the muscles and skin of the back. From this branch a *spinal twig* is supplied through the intervertebral foramen to the spinal cord and its membranes. In each space, the intercostal artery proceeds outwards, first lying between the posterior intercostal membrane and the pleura, and afterwards between the two muscular strata. Each artery is accompanied by a nerve and a vein. The vein usually occupies the *highest* level, the nerve the *lowest* level, whilst the artery is *intermediate.* The distribution of these vessels in the thoracic parietes has already been studied (p. 6).

The position of the intercostal artery in the intercostal

space is a matter of some surgical importance. At first it crosses the intercostal space obliquely, so as to gain the shelter of the subcostal groove of the rib which bounds the space above. It attains this position near the angle of the rib, and as it proceeds forwards the groove affords it a very efficient protection against wounds from without.

The intercostal arteries which supply the *two highest* intercostal spaces are derived from the *superior intercostal branch* of the subclavian artery. The superior intercostal artery descends upon the necks of the first two ribs, and external to the gangliated cord. It anastomoses with the first aortic intercostal artery, and sends outwards two vessels for the two highest spaces. Each of these, in turn, gives off a *dorsal branch* similar to the dorsal branches of the aortic intercostal arteries.

Subcostal Arteries.—These arteries form a pair of vessels in series with the intercostal arteries. They enter the abdomen by passing under the ligamentum arcuatum externum, and run in company with the last dorsal nerves along the lower borders of the last pair of ribs.

Intercostal Nerves.—The intercostal nerves pass outwards in company with the arteries. The connecting twigs which pass between these nerves and the sympathetic ganglia have already been noted. Each nerve lies at a lower level than the corresponding artery, and is at first placed between the posterior intercostal membrane and the pleura, and then between the two muscular strata. The further course of these nerves is described at p. 5.

The *first dorsal nerve* will be found passing upwards over the neck of the first rib to join the brachial plexus. It gives a small branch to the first intercostal space, but this nerve, although it is disposed after the manner of an intercostal nerve, does not furnish, as a rule, a lateral cutaneous or an anterior branch. The *second dorsal* or *intercostal nerve*, as a rule, sends a branch upwards over the neck of the second rib to join that portion of the first dorsal nerve which enters the brachial plexus. This communicating twig is usually minute and insignificant, but sometimes it is a large nerve; and, in these cases, the intercosto-humeral nerve, or lateral cutaneous branch of the second intercostal nerve, is very small or altogether absent.

Veins of the Thoracic Wall.—When the dissector has

traced the *intercostal veins* to their various destinations, he will find that they differ in their arrangement upon the two sides of the body. On the *right side* they terminate in three different ways :—

1. The intercostal vein of the first or highest space joins the *right innominate vein* (sometimes the *vertebral vein*).
2. The intercostal veins of the second and third spaces (and sometimes of the fourth space) unite into a common trunk, which joins the upper part of the *vena azygos major*. The common trunk is termed the *superior intercostal vein*.
3. The intercostal veins of the eight lower spaces join the *vena azygos major*.

On the *left side* of the body *four* modes of termination may be recognised :—

1. The intercostal vein of the first or highest space has the same termination as the corresponding vein of the right side. It joins the *left innominate vein* (sometimes the *vertebral vein* of its own side).
2. The intercostal veins of the second and third spaces (and sometimes of the fourth space) converge, and by their union form a single trunk, termed the *superior intercostal vein*, which crosses the arch of the aorta and joins the *left innominate vein* independently of the first intercostal vein.
3. The intercostal veins of the fourth, fifth, sixth, seventh, and eighth spaces terminate in the *vena azygos minor superior*.
4. The intercostal veins of the ninth, tenth, and eleventh spaces join the *vena azygos minor inferior*.

The azygos veins which thus receive the blood of the great majority of the intercostal veins should now be studied.

Vena Azygos Major (vena azygos).—This vein takes origin within the abdomen in the *right ascending lumbar vein* (vena lumbalis ascendens), a vessel which links together certain of the lumbar veins, and sometimes presents a direct communication with the common iliac vein. It enters the thorax through the aortic opening of the diaphragm, lying upon the right side of the thoracic duct and the aorta. In the thorax it extends upwards upon the bodies of the dorsal vertebræ and over the right intercostal arteries, until it reaches the level of the upper border of the root of the right lung. At this point it hooks forwards over the right bronchus, and ends by joining the superior vena cava. It is situated in the posterior mediastinum, with the aorta and thoracic duct lying to the left (Fig. 47, p. 88).

The *tributaries* of the vena azygos major are as follows :—(1) the superior intercostal vein of the right side; (2) the intercostal veins of the eight lower spaces of the right side;

(3) the vena azygos minor superior; (4) the vena azygos minor inferior; (5) the bronchial veins from the right lung; (6) certain of the œsophageal veins; (7) some minute pericardiac veins.

The vena azygos major communicates below with some of the lumbar veins—tributaries of the inferior vena cava; whilst above, it pours its blood into the superior vena cava. In this way it forms a link by which the superior vena cava is brought into connection with the inferior vena cava.

Vena Azygos Minor Superior (vena hemiazygos accessoria).—This vein is formed on the left side of the body by the union of the intercostal veins of the fourth, fifth, sixth, seventh, and eighth spaces. It communicates above with the left superior intercostal vein, which carries the blood from the second and third intercostal spaces to the left innominate vein. At the level of the eighth dorsal vertebra it turns inwards behind the aorta and thoracic duct, and crossing the middle line ends by joining the vena azygos major. In many cases, however, it joins the vena azygos minor inferior. In addition to the intercostal veins it receives the left bronchial veins.

Vena Azygos Minor Inferior (vena hemiazygos).—This vein takes origin within the abdomen as the *left ascending lumbar vein.* It enters the thorax by piercing the left crus of the diaphragm, and is continued upwards upon the vertebral column as far as the ninth dorsal vertebra. At this point it turns to the right, and crossing behind the aorta and the thoracic duct, it joins the vena azygos major independently of the vena azygos minor superior.

The tributaries of this vein are the intercostal veins of the three lower spaces of the left side.

The veins of the thoracic parietes are extremely variable, and the above description of them must be looked upon as merely representing their more usual arrangement.

THORACIC JOINTS.

The student should now complete the dissection of the thorax by an examination of the various thoracic joints.

Dissection.—The portion of the sternum with the cartilages of the ribs which was laid aside, together with the other joints in connection with the anterior wall of the thorax, should now be dissected. Inter-sternal, costo-

sternal, and inter-chondral articulations require examination. Very little dissection is necessary. After the ligaments have been defined, the dissector should remove a thin slice from the anterior aspect of each articulation, in order that the interior of the joint may be displayed.

Manubrio-gladiolar Articulation.—This joint, between the manubrium and the gladiolus of the sternum, partakes of the nature of an amphiarthrosis. The opposing surfaces of bone are covered by a layer of hyaline cartilage, and are united by intermediate fibro-cartilage. The joint is supported by some anterior and posterior longitudinal fibres which are developed in connection with the strong and thick periosteum. The posterior ligament is the stronger of the two.

Sterno-chondral Articulations.—Seven ribs articulate, by means of their cartilages, directly with each side of the sternum. The articulations of the first and the sixth are peculiar, inasmuch as they articulate with single pieces of the sternum, viz., with the manubrium and the lowest piece of the gladiolus respectively, whereas each of the cartilages of the other true ribs articulates with two segments of the sternum. The cartilage of the first rib is implanted upon the side of the manubrium without any synovial membrane, or other material, intervening. The second costal cartilage is usually separated from the sternum by two synovial membranes, between which an interarticular ligament is developed. In the case of the other joints it is more common to find a single synovial cavity and no interarticular ligament. There is, however, considerable variety in these articulations, and a synovial membrane is very frequently wanting altogether in the sterno-chondral joint of the seventh costal cartilage.

With the exception of the first, and very frequently the seventh, the sterno-chondral joints belong to the diarthrodial variety. They are provided with anterior and posterior ligaments, and also, in those cases where the joint presents a double synovial cavity, with an interarticular ligament.

The *anterior* and *posterior ligaments* (ligamenta sterno-costalia radiata) are strong, flattened bands of fibres which radiate rom the extremities of the rib-cartilages, and blend with the eriosteum on the anterior and posterior surfaces of the ternum. The *interarticular ligaments* are feeble bands which ass from the tips of the rib-cartilages to the sternum, and ivide the articulations in which they exist into an upper and lower compartment, each lined by a synovial membrane.

branches. The first hyparterial division on each side (*i.e.* the branch to the middle lobe of the right side, and the branch to the upper lobe of the left side) may be regarded as the first member of the ventral group (Fig. 48).

It should be observed that when the bronchial tubes enter the lung, they cease to be flattened posteriorly, and become uniformly cylindrical. This is due to the cartilage being disposed around the tube on all its aspects, in the form of irregular flakes, and imperfect rings. The farther the tubes are traced, the scarcer and finer become the particles of cartilage.

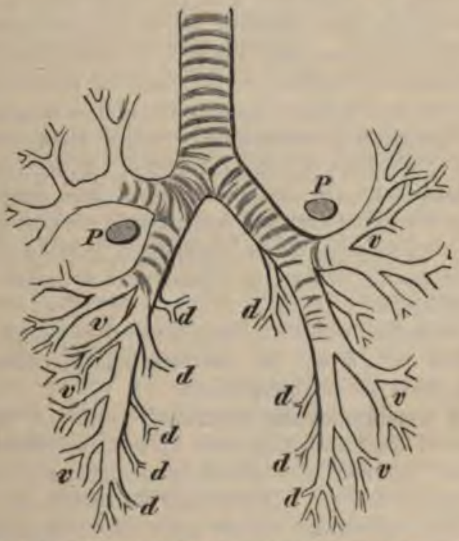

FIG. 48.—Schema of the Branching of the Two Bronchi. (From Gegenbaur.)

P. Pulmonary artery; *d.* Dorsal divisions of the bronchi; *v.* Ventral divisions of the bronchi. The highest *v* on each side indicates the first hyparterial bronchus, or, in other words, the branch to the upper lobe of the left lung and the middle lobe on the right lung.

The *pulmonary vessels* in the substance of the lungs run with the bronchi. The *veins* still keep to the front of the air-passages; the *arteries*, however, as we have noted, turn backwards to reach their posterior aspect, and this relation they maintain in the lung substance.

But the vertebral extremities of the ribs present another series of articulations. The upper ten ribs, by means of their tubercles, rest upon and articulate with the extremities of the transverse processes of the corresponding dorsal vertebræ. These joints are termed the *costo-transverse articulations* (articulationes costo-transversariæ). The eleventh and twelfth ribs have no tubercles, and do not articulate with the transverse processes of the vertebræ with which they are connected.

Capitular Joints.—These joints belong to the diarthrodial variety, and are provided with—(1) an anterior capitular ligament; (2) an interarticular ligament; and (3) two synovial membranes. In the case of the four ribs, however, which articulate with the body of one vertebra alone (viz., the first, tenth, eleventh, and twelfth), the joint cavity is single.

The *anterior capitular* or *stellate ligament* (ligamentum capituli costæ radiatum) is placed in front of the joint. It is composed of strong fibres, which radiate in a fan-shaped manner from the head of the rib. Its vertebral attachment is effected by three, more or less distinct, slips—(1) the uppermost, which is the largest, passes upwards and inwards to the body of the vertebra, which forms the upper part of the socket for the head of the rib; (2) the middle slip is attached to the intervertebral disc; and (3) the lowest slip goes to the body of the vertebra below the head of the rib. The part of the joint uncovered by the stellate ligament is surrounded by short fibres which form *a capsule*, enclosing the synovial membranes.

In the four joints in which the head of the rib is in contact with the body of one vertebra, the stellate ligament is composed of only two slips. Of these, the *lower* is attached to the body of the vertebra which supports the rib, whilst the *upper* passes upwards to the lower border of the vertebral body immediately above.

Dissection.—The interarticular ligament may be exposed by removing the stellate ligament from the front of the joint.

The *interarticular ligament* of the capitular joints is composed of short strong fibres which are attached, on the one hand, to the ridge between the two articular facets on the head of the rib, and on the other hand to the intervertebral disc. It divides the joint into two synovial cavities, and it is

absent in those cases in which the head of the rib articulates with the body of one vertebra.

The *synovial membranes* are two in number, except in the capitular joints of the first and last three ribs. One is placed above, and the other below the interarticular ligament.

Costo-transverse Articulations.—These are provided with capsular ligaments, and with superior, middle, and posterior costo-transverse ligaments. Each joint cavity is lined by a synovial membrane.

The *superior costo-transverse ligament* (ligamentum costo-transversarium anterius) passes obliquely downwards and inwards from the lower border of the transverse process to the upper border of the neck of the rib next below it. Its internal margin is thick and well defined, and its outer border becomes continuous with the posterior intercostal membrane.

The *interosseous costo-transverse ligament* (ligamentum costo-transversarium posterius) consists of fibrous bands which pass between the neck of the rib and the anterior surface of the transverse process against which it rests.

The fibres of this ligament are so short that it is exceedingly difficult to obtain a proper view of them. The best plan is to saw off, in a horizontal direction, the upper parts of the neck of the rib and the transverse process to which it is attached.

The *posterior costo-transverse ligament* (ligamentum tuberculi costæ) is a strong flattened band which passes, on the posterior aspect of the joint, from the tip of the transverse process to the rough portion of the tubercle of the rib.

The posterior costo-transverse ligament, supplemented by a few fibres which surround the synovial membrane of the joint, forms the *capsular ligament*. When the posterior costo-transverse ligament is removed, the *synovial membrane* is displayed.

Intervertebral Articulations.—The *bodies* of the vertebræ are held together by a series of amphiarthrodial joints, supported in front by an anterior common ligament, and behind by a posterior common ligament. The *neural arches*, by means of the articular processes, form a series of diarthrodial joints surrounded by capsular ligaments, and lined by synovial membranes. Certain ligaments pass between different portions of the neural arches and their processes, viz., the ligamenta subflava between adjacent laminæ, the inter-transverse, the inter-spinous, and the supra-spinous ligaments.

The *posterior intercostal membrane* is a strong aponeurotic layer which is continuous internally with the outer margin of the superior costo-transverse ligament, and extends outwards upon the deep surface of the external intercostal muscle. At the inner margin of the internal intercostal muscle it passes between the two intercostal muscular strata and is gradually lost. The intercostal vessels and nerve extend outwards upon its anterior aspect under cover of the pleura.

The *subcostal muscles* are also displayed. They are small fleshy fasciculi placed upon the ribs, internal to their angles. The muscular fibres which compose them have the same direction as the internal intercostal muscles. They extend over one or, in many cases, two intercostal spaces.

Dissection.—Remove the posterior intercostal membrane from one or two of the spaces, and the subjacent *external intercostal muscles* will be brought into view. These muscles reach backwards as far as the tubercles of the ribs.

Intercostal Arteries.—The *aortic intercostal arteries* have already been seen taking origin from the thoracic aorta. One is given to each of the nine lower intercostal spaces upon both sides of the body. As the aorta lies somewhat to the left of the middle line, the right aortic intercostal arteries are longer than those of the left side. In both cases they run outwards over the bodies of the vertebræ, and under cover of the gangliated cord of the sympathetic. On the right side, the arteries also pass under cover of the œsophagus, the thoracic duct, and the vena azygos major. As they leave the vertebral column to enter the intercostal spaces, each of the vessels gives off a large *dorsal branch* which passes backwards in the interval between the transverse processes and is distributed to the muscles and skin of the back. From this branch a *spinal twig* is supplied through the intervertebral foramen to the spinal cord and its membranes. In each space, the intercostal artery proceeds outwards, first lying between the posterior intercostal membrane and the pleura, and afterwards between the two muscular strata. Each artery is accompanied by a nerve and a vein. The vein usually occupies the *highest* level, the nerve the *lowest* level, whilst the artery is *intermediate*. The distribution of these essels in the thoracic parietes has already been studied p. 6).

The position of the intercostal artery in the intercostal

space is a matter of some surgical importance. At first it crosses the intercostal space obliquely, so as to gain the shelter of the subcostal groove of the rib which bounds the space above. It attains this position near the angle of the rib, and as it proceeds forwards the groove affords it a very efficient protection against wounds from without.

The intercostal arteries which supply the *two highest* intercostal spaces are derived from the *superior intercostal branch* of the subclavian artery. The superior intercostal artery descends upon the necks of the first two ribs, and external to the gangliated cord. It anastomoses with the first aortic intercostal artery, and sends outwards two vessels for the two highest spaces. Each of these, in turn, gives off a *dorsal branch* similar to the dorsal branches of the aortic intercostal arteries.

Subcostal Arteries.—These arteries form a pair of vessels in series with the intercostal arteries. They enter the abdomen by passing under the ligamentum arcuatum externum, and run in company with the last dorsal nerves along the lower borders of the last pair of ribs.

Intercostal Nerves.—The intercostal nerves pass outwards in company with the arteries. The connecting twigs which pass between these nerves and the sympathetic ganglia have already been noted. Each nerve lies at a lower level than the corresponding artery, and is at first placed between the posterior intercostal membrane and the pleura, and then between the two muscular strata. The further course of these nerves is described at p. 5.

The *first dorsal nerve* will be found passing upwards over the neck of the first rib to join the brachial plexus. It gives a small branch to the first intercostal space, but this nerve, although it is disposed after the manner of an intercostal nerve, does not furnish, as a rule, a lateral cutaneous or an anterior branch. The *second dorsal* or *intercostal nerve*, as a rule, sends a branch upwards over the neck of the second rib to join that portion of the first dorsal nerve which enters the brachial plexus. This communicating twig is usually minute and insignificant, but sometimes it is a large nerve; and, in these cases, the intercosto-humeral nerve, or lateral cutaneous branch of the second intercostal nerve, is very small or altogether absent.

Veins of the Thoracic Wall.—When the dissector has

traced the *intercostal veins* to their various destinations, he will find that they differ in their arrangement upon the two sides of the body. On the *right side* they terminate in three different ways :—

1. The intercostal vein of the first or highest space joins the *right innominate vein* (sometimes the *vertebral vein*).
2. The intercostal veins of the second and third spaces (and sometimes of the fourth space) unite into a common trunk, which joins the upper part of the *vena azygos major.* The common trunk is termed the *superior intercostal vein.*
3. The intercostal veins of the eight lower spaces join the *vena azygos major.*

On the *left side* of the body *four* modes of termination may be recognised :—

1. The intercostal vein of the first or highest space has the same termination as the corresponding vein of the right side. It joins the *left innominate vein* (sometimes the *vertebral vein* of its own side).
2. The intercostal veins of the second and third spaces (and sometimes of the fourth space) converge, and by their union form a single trunk, termed the *superior intercostal vein*, which crosses the arch of the aorta and joins the *left innominate vein* independently of the first intercostal vein.
3. The intercostal veins of the fourth, fifth, sixth, seventh, and eighth spaces terminate in the *vena azygos minor superior.*
4. The intercostal veins of the ninth, tenth, and eleventh spaces join the *vena azygos minor inferior.*

The azygos veins which thus receive the blood of the great majority of the intercostal veins should now be studied.

Vena Azygos Major (vena azygos).—This vein takes origin within the abdomen in the *right ascending lumbar vein* (vena lumbalis ascendens), a vessel which links together certain of the lumbar veins, and sometimes presents a direct communication with the common iliac vein. It enters the thorax through the aortic opening of the diaphragm, lying upon the right side of the thoracic duct and the aorta. In the thorax it extends upwards upon the bodies of the dorsal vertebræ and over the right intercostal arteries, until it reaches the level of the upper border of the root of the right lung. At this point it hooks forwards over the right bronchus, and ends by joining the superior vena cava. It is situated in the posterior mediastinum, with the aorta and thoracic duct lying to the left (Fig. 47, p. 88).

The *tributaries* of the vena azygos major are as follows :—(1) the superior intercostal vein of the right side; (2) the intercostal veins of the eight lower spaces of the right side;

(3) the vena azygos minor superior; (4) the vena azygos minor inferior; (5) the bronchial veins from the right lung; (6) certain of the œsophageal veins; (7) some minute pericardiac veins.

The vena azygos major communicates below with some of the lumbar veins—tributaries of the inferior vena cava; whilst above, it pours its blood into the superior vena cava. In this way it forms a link by which the superior vena cava is brought into connection with the inferior vena cava.

Vena Azygos Minor Superior (vena hemiazygos accessoria).—This vein is formed on the left side of the body by the union of the intercostal veins of the fourth, fifth, sixth, seventh, and eighth spaces. It communicates above with the left superior intercostal vein, which carries the blood from the second and third intercostal spaces to the left innominate vein. At the level of the eighth dorsal vertebra it turns inwards behind the aorta and thoracic duct, and crossing the middle line ends by joining the vena azygos major. In many cases, however, it joins the vena azygos minor inferior. In addition to the intercostal veins it receives the left bronchial veins.

Vena Azygos Minor Inferior (vena hemiazygos).—This vein takes origin within the abdomen as the *left ascending lumbar vein.* It enters the thorax by piercing the left crus of the diaphragm, and is continued upwards upon the vertebral column as far as the ninth dorsal vertebra. At this point it turns to the right, and crossing behind the aorta and the thoracic duct, it joins the vena azygos major independently of the vena azygos minor superior.

The tributaries of this vein are the intercostal veins of the three lower spaces of the left side.

The veins of the thoracic parietes are extremely variable, and the above description of them must be looked upon as merely representing their more usual arrangement.

THORACIC JOINTS.

The student should now complete the dissection of the thorax by an examination of the various thoracic joints.

Dissection.—The portion of the sternum with the cartilages of the ribs which was laid aside, together with the other joints in connection with the anterior wall of the thorax, should now be dissected. Inter-sternal, costo-

sternal, and inter-chondral articulations require examination. Very little dissection is necessary. After the ligaments have been defined, the dissector should remove a thin slice from the anterior aspect of each articulation, in order that the interior of the joint may be displayed.

Manubrio-gladiolar Articulation.—This joint, between the manubrium and the gladiolus of the sternum, partakes of the nature of an amphiarthrosis. The opposing surfaces of bone are covered by a layer of hyaline cartilage, and are united by intermediate fibro-cartilage. The joint is supported by some anterior and posterior longitudinal fibres which are developed in connection with the strong and thick periosteum. The posterior ligament is the stronger of the two.

Sterno-chondral Articulations.—Seven ribs articulate, by means of their cartilages, directly with each side of the sternum. The articulations of the first and the sixth are peculiar, inasmuch as they articulate with single pieces of the sternum, viz., with the manubrium and the lowest piece of the gladiolus respectively, whereas each of the cartilages of the other true ribs articulates with two segments of the sternum. The cartilage of the first rib is implanted upon the side of the manubrium without any synovial membrane, or other material, intervening. The second costal cartilage is usually separated from the sternum by two synovial membranes, between which an interarticular ligament is developed. In the case of the other joints it is more common to find a single synovial cavity and no interarticular ligament. There is, however, considerable variety in these articulations, and a synovial membrane is very frequently wanting altogether in the sterno-chondral joint of the seventh costal cartilage.

With the exception of the first, and very frequently the seventh, the sterno-chondral joints belong to the diarthrodial variety. They are provided with anterior and posterior ligaments, and also, in those cases where the joint presents a double synovial cavity, with an interarticular ligament.

The *anterior* and *posterior ligaments* (ligamenta sterno-costalia radiata) are strong, flattened bands of fibres which radiate from the extremities of the rib-cartilages, and blend with the periosteum on the anterior and posterior surfaces of the sternum. The *interarticular ligaments* are feeble bands which pass from the tips of the rib-cartilages to the sternum, and divide the articulations in which they exist into an upper and a lower compartment, each lined by a synovial membrane.

Inter-chondral Articulations.—These joints are formed between the adjacent margins of the costal cartilages of some of the lower ribs (generally from the fifth or sixth to the ninth). They are protected by capsules formed by strong oblique ligamentous fibres, and are lined by synovial membranes.

Costo-vertebral Articulations.—With the exception of the first and the last three ribs, the head of each rib articulates with the bodies of two vertebræ and the intervening intervertebral substance (articulatio capituli costæ). The costal head is wedge-shaped, and the socket formed for its reception presents a corresponding form. From the intervertebral disc taking part in the formation of the socket, a certain amount of elasticity is communicated to the joint, and shocks given to the thoracic wall are the more successfully counteracted. The heads of the first, tenth, eleventh, and twelfth ribs are implanted directly upon the bodies of the corresponding vertebræ, although in the case of the first rib the intervertebral disc immediately above also, as a rule, takes a considerable share in the formation of its socket. The articulations between the heads of the ribs and the bodies of the vertebræ are termed the *capitular joints* (articulationes capitulorum).

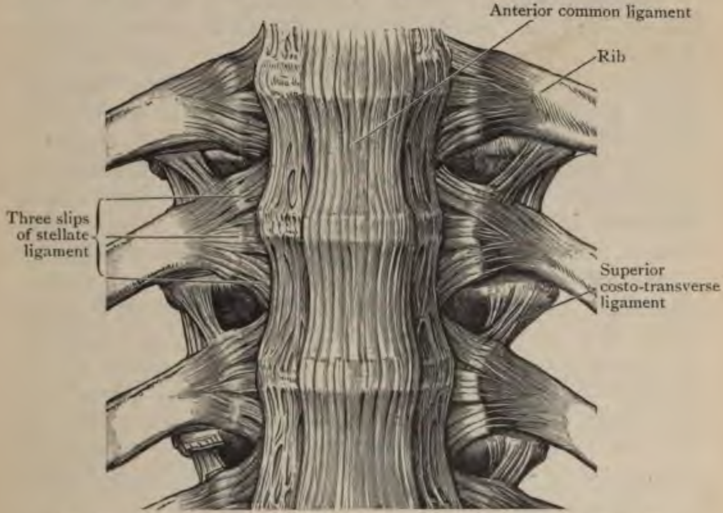
Anterior common ligament
Rib
Three slips of stellate ligament
Superior costo-transverse ligament

FIG. 49.—Costo-vertebral Joints as seen from the front; also Anterior Common Ligament of Vertebral Column.

But the vertebral extremities of the ribs present another series of articulations. The upper ten ribs, by means of their tubercles, rest upon and articulate with the extremities of the transverse processes of the corresponding dorsal vertebræ. These joints are termed the *costo-transverse articulations* (articulationes costo-transversariæ). The eleventh and twelfth ribs have no tubercles, and do not articulate with the transverse processes of the vertebræ with which they are connected.

Capitular Joints.—These joints belong to the diarthrodial variety, and are provided with—(1) an anterior capitular ligament; (2) an interarticular ligament; and (3) two synovial membranes. In the case of the four ribs, however, which articulate with the body of one vertebra alone (viz., the first, tenth, eleventh, and twelfth), the joint cavity is single.

The *anterior capitular* or *stellate ligament* (ligamentum capituli costæ radiatum) is placed in front of the joint. It is composed of strong fibres, which radiate in a fan-shaped manner from the head of the rib. Its vertebral attachment is effected by three, more or less distinct, slips—(1) the uppermost, which is the largest, passes upwards and inwards to the body of the vertebra, which forms the upper part of the socket for the head of the rib; (2) the middle slip is attached to the intervertebral disc; and (3) the lowest slip goes to the body of the vertebra below the head of the rib. The part of the joint uncovered by the stellate ligament is surrounded by short fibres which form *a capsule*, enclosing the synovial membranes.

In the four joints in which the head of the rib is in contact with the body of one vertebra, the stellate ligament is composed of only two slips. Of these, the *lower* is attached to the body of the vertebra which supports the rib, whilst the *upper* passes upwards to the lower border of the vertebral body immediately above.

Dissection.—The interarticular ligament may be exposed by removing the stellate ligament from the front of the joint.

The *interarticular ligament* of the capitular joints is composed of short strong fibres which are attached, on the one hand, to the ridge between the two articular facets on the head of the rib, and on the other hand to the intervertebral disc. It divides the joint into two synovial cavities, and it is

absent in those cases in which the head of the rib articulates with the body of one vertebra.

The *synovial membranes* are two in number, except in the capitular joints of the first and last three ribs. One is placed above, and the other below the interarticular ligament.

Costo-transverse Articulations.—These are provided with capsular ligaments, and with superior, middle, and posterior costo-transverse ligaments. Each joint cavity is lined by a synovial membrane.

The *superior costo-transverse ligament* (ligamentum costo-transversarium anterius) passes obliquely downwards and inwards from the lower border of the transverse process to the upper border of the neck of the rib next below it. Its internal margin is thick and well defined, and its outer border becomes continuous with the posterior intercostal membrane.

The *interosseous costo-transverse ligament* (ligamentum costo-transversarium posterius) consists of fibrous bands which pass between the neck of the rib and the anterior surface of the transverse process against which it rests.

The fibres of this ligament are so short that it is exceedingly difficult to obtain a proper view of them. The best plan is to saw off, in a horizontal direction, the upper parts of the neck of the rib and the transverse process to which it is attached.

The *posterior costo-transverse ligament* (ligamentum tuberculi costæ) is a strong flattened band which passes, on the posterior aspect of the joint, from the tip of the transverse process to the rough portion of the tubercle of the rib.

The posterior costo-transverse ligament, supplemented by a few fibres which surround the synovial membrane of the joint, forms the *capsular ligament*. When the posterior costo-transverse ligament is removed, the *synovial membrane* is displayed.

Intervertebral Articulations.—The *bodies* of the vertebræ are held together by a series of amphiarthrodial joints, supported in front by an anterior common ligament, and behind by a posterior common ligament. The *neural arches*, by means of the articular processes, form a series of diarthrodial joints surrounded by capsular ligaments, and lined by synovial membranes. Certain ligaments pass between different portions of the neural arches and their processes, viz., the ligamenta subflava between adjacent laminæ, the inter-transverse, the inter-spinous, and the supra-spinous ligaments.

The laminæ and the spinous processes of the vertebræ have been removed by the dissector of the head and neck in opening up the spinal canal to display the spinal cord. Consequently, the ligamenta subflava, the inter-spinous and supra-spinous ligaments, cannot be seen at present.

The *anterior common ligament* (ligamentum longitudinale anterius) is situated in front of the bodies of the vertebræ, and extends from the axis vertebra above to the first piece of the sacrum below. It consists of stout glistening fibrous bands, which are firmly attached to the margins of the vertebral bodies and to the intervertebral discs. The most superficial fibres are the longest, and extend from a given vertebra to the fourth or fifth below it. The deeper fibres have a shorter course, and pass between the borders of two, three, or four adjacent vertebræ. The dissector cannot fail to notice that the origin of the longus colli muscle is inseparably connected with this ligament.

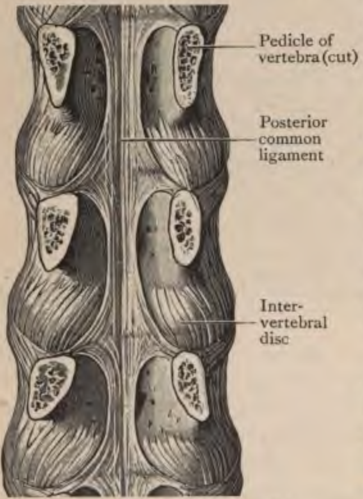

FIG. 50.—Posterior Common Ligament of the Vertebral Column. The neural arches have been removed from the vertebræ.

The *posterior common ligament* (ligamentum longitudinale posterius) is placed on the back of the vertebral bodies, and therefore within the spinal canal. It is firmly connected to the margins of the vertebral bodies, and to the intervertebral discs, but is separated from the central parts of the bodies by some loose connective tissue and by a plexus of veins. It is constricted where it covers this venous plexus, but widens out opposite the intervertebral discs. It therefore presents a scalloped or denticulated appearance.

The *intervertebral substance* (fibro-cartilago intervertebralis) is disposed between the vertebræ in a series of flattened discs of white fibro-cartilage which correspond in outline to the vertebræ between which they are situated. The peripheral part of each disc is tough and fibrous (annulus fibrosus), the central portion soft and pulpy (nucleus pulposus). In a transverse section the peripheral portion appears concentrically laminated: in a vertical section the most peripheral laminæ are seen to be bent with the convexity turned away from the centre of the disc, the most central laminæ to be bent in the opposite direction, and the intermediate laminæ to be nearly straight. It will be easily seen that this remarkable arrangement increases the elasticity of the spine, and tends to restore it to its natural curvature after it has been deflected by muscular action.

The intervertebral discs constitute the main bond of union between the bodies of the vertebræ, but, except in old people, they are not directly attached to the bone. A thin layer of encrusting hyaline cartilage coats the opposing vertebral surfaces.

Vertical and transverse sections must be made through two or more of the intervertebral discs, in order that their structure may be displayed.

The facets of the *articular processes* are coated by hyaline cartilage. A capsular ligament lined by a synovial membrane encloses each joint.

The *intertransverse ligaments* are feeble bands which pass between the tips of the transverse processes. In the lower part of the dorsal regions they are intimately blended with the intertransverse muscles: in the middle and upper parts of the dorsal region they entirely replace the muscles.

HEAD AND NECK.

The dissector of the Head and Neck begins work on the same day that the subject is brought into the dissecting-room. It is placed on a short table for this purpose; and of the two days during which it remains in the lithotomy position, the *first* should be devoted to the dissection of the scalp, and the *second* to the removal of the brain.

SCALP.

Strictly speaking, the term "scalp" should be restricted to the soft parts which cover the vault of the cranium above the level of the temporal ridges and the superior curved line of the occipital bone, but it is convenient to dissect at the same time the superficial structures in the temporal regions.

Above the level of the temporal ridges we meet with five strata as we dissect from the surface to the bone, viz.—(1) the skin; (2) the superficial fascia; (3) the occipito-frontalis muscle, with its extensive epicranial aponeurosis; (4) a layer of loose areolar tissue; and (5) the periosteum, which is here termed the pericranium.

Below the level of the temporal ridges additional structures are observed coating the cranium. As many as eight layers may be recognised, viz.—(1) skin; (2) superficial fascia; (3) the small extrinsic muscles of the ear; (4) the thin lateral part of the epicranial aponeurosis; (5) a thin layer of fascia descending from the temporal ridge to the pinna; (6) the temporal fascia; (7) the temporal muscle; (8) the periosteum.

The scalp is richly supplied with both nerves and blood-vessels.

Dissection.—The dissector should place a block under the head so as to raise it to a convenient height, and proceed with the dissection.

Three incisions through the skin are required, viz.—(1) from the root of the nose along the middle line of the cranium, to a point a little beyond the external occipital protuberance; (2) from the tip of the mastoid process on one side, over the summit of the head to a corresponding point upon the opposite side; (3) from a point on the latter incision immediately above the pinna on each side downwards in front of the auricle to the root of the zygoma. Four flaps of skin are thus marked out, and these should be carefully raised from the subjacent superficial fascia. This, however, is no easy matter, owing to the very firm connection which exists between them. The roots of the hair which pierce the integument obliquely, and are embedded in the superficial fascia, add another difficulty to the proper reflection of the integument.

Superficial Fascia.—On the summit of the cranium the superficial fascia, although thin, is exceedingly dense and tough, owing to strong septa of fibrous tissue which bind it on the one hand to the integument, and on the other to the subjacent epicranial aponeurosis. The meshes formed by these fibrous processes are filled with small lobules of fat, which give this layer a granular appearance. As the fascia is traced forwards towards the forehead, and downwards on each side towards the ears, it loses in great part its dense fibrous character, and becomes looser and less fatty. It is in the superficial fascia that the cutaneous vessels and nerves ramify before they enter the skin.

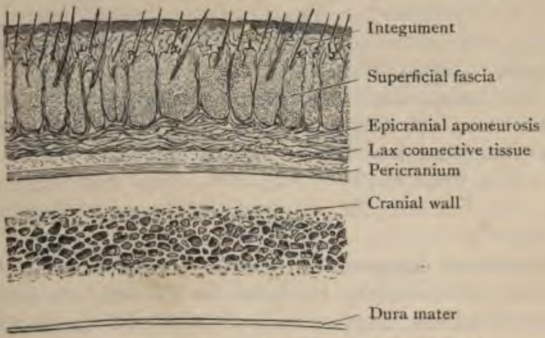

FIG. 51.—Section through the Scalp and Cranial Wall.

Dissection.—The superficial fascia may now be removed from the surface of the occipito-frontalis. In doing this, the dissector must proceed very cautiously, so as not to injure the cutaneous nerves and blood vessels which ramify in its midst. It is impossible, owing to its density, to raise it in one layer; it must be taken away piecemeal.

Occipito-frontalis (epicranius).—This is a quadricipital muscle which presents two occipital and two frontal bellies. The *occipital bellies* (musculi occipitales)—Fig. 52 (2)—are quite distinct from each other, and are separated by a marked interval. Each arises from the outer two-thirds of the superior curved line of the occipital bone, and from a small portion of the adjoining part of the mastoid process of the temporal bone immediately above the insertion of the sterno-mastoid. From this the fibres ascend for a distance of about two inches in the form of a thin, dark-red, fleshy layer, which is inserted into the epicranial aponeurosis.

The *frontal bellies* (musculi frontales) are composed of pale fibres, and are not perfectly distinct from each other. For a short distance above the root of the nose their inner margins are blended along the middle line. Above this, however, they diverge slightly, and are separated by a narrow interval. They possess little or no direct attachment to the bone. The greater number of the fibres mingle with those of the orbicularis palpebrarum and the corrugator supercilii muscles, and gain an attachment to the integument and subcutaneous tissue over the eyebrow, whilst a few of the innermost fibres proceed downwards upon the nasal bone to form the pyramidalis nasi muscle. Ascending upon the forehead, the frontal bellies are inserted near the line of the coronal suture into the epicranial aponeurosis.

Epicranial Aponeurosis (galea aponeurotica).—This aponeurosis connects the occipital and frontal bellies of the occipito-frontalis muscle, and constitutes a continuous layer over the summit and sides of the head. Posteriorly it can be traced backwards in the interval between the two occipital bellies of the muscle, when it will be observed to have an attachment to the external occipital protuberance and the superior curved line of the occipital bone. Laterally, it presents no sharply defined margin, but, losing its aponeurotic character, it is prolonged downwards as a fine expansion over the temporal fascia. In this locality it gives origin to two of the small auricular muscles.

Dissection.—Divide the epicranial aponeurosis by a mesial incision of about an inch and a half in length, and then carry across the middle of this a second short transverse cut. On raising the corners thus marked out, the aponeurosis will be seen to rest upon a layer of loose flocculent areolar tissue, containing no fat—the *fourth stratum* of the scalp. Owing to the great laxity of this tissue, the occipito-frontalis muscle by its contractions can move the hairy scalp freely over the pericranium which invests the bone.

Extrinsic Muscles of the Ear.—In man these muscles are very poorly developed, and the auricle possesses in consequence only a very limited power of independent movement. They are three in number, viz.:—

1. Attollens auriculam.
2. Attrahens auriculam.
3. Retrahens auriculam.

The first two of these are so thin that it requires an experienced and careful dissector to isolate them from the superficial fascia.

Attollens auriculam (musculus auricularis superior)—Fig. 52 (1).—To expose this muscle the upper part of the auricle must be dragged downwards, and then fixed in this position by means of a hook. The muscular fibres are thus rendered tense and stand out in relief. When cleaned it will be seen to be a fan-shaped muscle, placed immediately above the ear. Above, it is broad, and arises from the epicranial aponeurosis where it covers the temporal fascia; below, the fibres converge as they approach the auricle and gain an insertion into the upper part of the cranial surface of the pinna.

The *attrahens auriculam* (musculus auricularis anterior), which is smaller than the preceding, is placed in front of the ear, and the auricle must therefore be pulled backwards in order that its fibres may be rendered tense. It arises on the surface of the temporal fascia from the epicranial aponeurosis, and it is inserted into the anterior aspect of the helix of the pinna.

The *retrahens auriculam* (musculus auricularis posterior)—Fig. 52 (3)—consists of two or three short bundles of muscular fibres which spring from the mastoid process of the temporal bone, and are inserted into the posterior part of the concha. It is readily exposed by drawing the ear forwards.

The *attrahens auriculam* is supplied by a twig from the temporal branches of the facial nerve; the *retrahens* and *attollens* by the posterior auricular branch of the facial nerve.

Nerves of the Scalp. — Two nerves are given to the *frontal* and *parietal* portions of the scalp by the frontal branch of the ophthalmic division of the trigeminal nerve. These are (*a*) the supra-trochlear, (*b*) the supra-orbital.

The *supra-trochlear nerve* (nervus supra-trochlearis) leaves the orbit close to its inner angle and then turns upwards

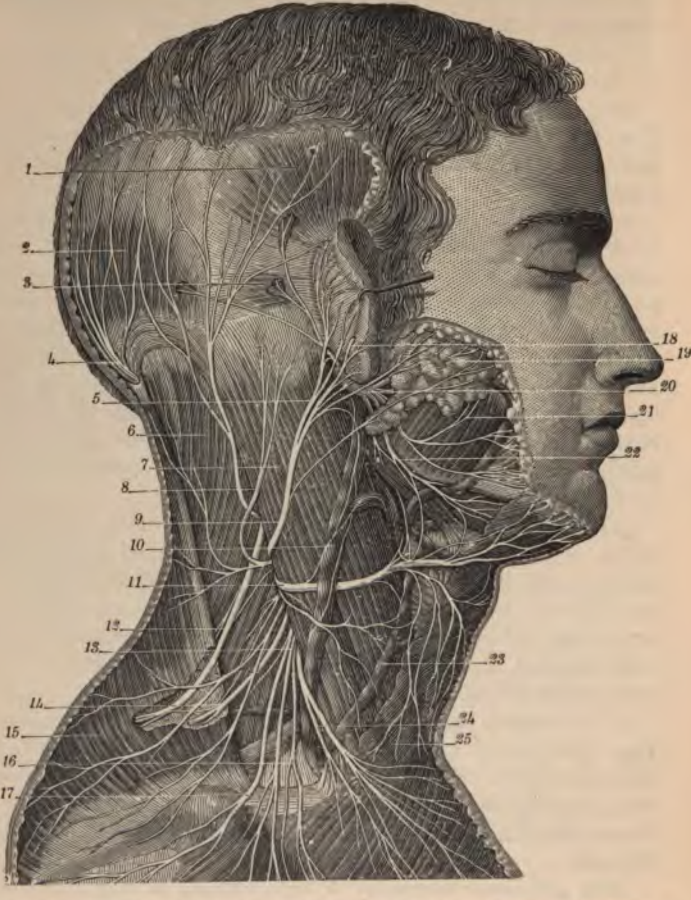

FIG. 52.—Superficial Nerves on the Side of the Neck and Back of the Scalp. (Hirschfeld and Leveillé.)

1. Attollens auriculam.
2. Posterior belly of occipito-frontalis.
3. Retrahens auriculam.
4. Great occipital nerve.
5. Great auricular nerve.
6. Splenius muscle.
7. Sterno-mastoid muscle.
8. Small occipital nerve (present as two branches).
9. Great auricular nerve.
10. External jugular vein.
11. Superficial cervical nerve.
12. Spinal accessory nerve.
13. Descending branches of cervical plexus.
14. Cervical branches to trapezius.
15. Trapezius muscle.
16. Clavicular branches.
17. Acromial branches.
18. Auricular twigs of great auricular nerve.
19. Parotid gland.
20. Facial nerve.
21. Masseter muscle.
22. Infra-mandibular nerve.
23. Anterior jugular vein.
24. Sternal branches.
25. Platysma myoides.

under cover of the orbicularis palpebrarum. It becomes superficial by piercing the frontal portion of the occipito-frontalis, and, after a short course in the superficial fascia, it ends in the integument of the forehead.

The *supra-orbital nerve* (nervus supra-orbitalis) is much larger than the preceding, and quits the orbit by turning upwards in the supra-orbital notch. The position of this notch in the superior margin of the orbit can generally be detected by the finger. The nerve now ascends under cover of the orbicularis palpebrarum and the frontal belly of the occipito-frontalis, and divides into an inner and an outer division. There is a slight difference in the manner in which these reach the surface. The *inner division* becomes superficial by piercing the anterior belly of the occipito-frontalis, whilst the *outer division* comes to the surface a little farther back by piercing the epicranial aponeurosis. Both ramify in the superficial fascia over the parietal bone, and give numerous twigs to the skin. The outer division can be traced as far back as the lambdoidal suture.

In the *temporal region*, nerves from three sources are to be found,—(*a*) from the facial nerve; (*b*) from the orbital branch of the superior maxillary division of the trigeminal nerve; (*c*) from the auriculo-temporal branch of the inferior maxillary division of the trigeminal nerve.

The *temporal branches of the facial nerve* will be noticed running upwards over the zygoma. They furnish twigs of supply to the attrahens auriculam, frontal belly of the occipito-frontalis, orbicularis palpebrarum, and corrugator supercilii.

The *temporal branch of the orbital nerve* (ramus zygomaticotemporalis) is a minute twig, which is somewhat difficult to find. If the finger be carried downwards from the external angular process of the frontal bone along the posterior margin of the malar bone, a tubercle on the latter will be felt. This is the guide to the temporal branch of the orbital nerve; it pierces the temporal fascia immediately behind it. It therefore makes its appearance about one inch above the anterior part of the zygoma, and the dissector is frequently led to it by a communicating twig from one of the facial branches. It is distributed to a limited area of skin in this region.

The *auriculo-temporal nerve* (nervus auriculotemporalis) will be found immediately in front of the ear, in close contact with the superficial temporal artery. It soon divides into two branches, which diverge from each other as they ascend, and a careful dissector may be able to trace twigs from these as far as the summit of the head. Its branches terminate in the skin of the scalp.

In the *mastoid* and *occipital regions* of the scalp, the dissector will meet with *four* nerves, each from a different source: (*a*) the posterior auricular branch of the facial nerve—Fig. 52 (3); (*b*) the mastoid branch of the great auricular nerve; (*c*) the small occipital nerve from the anterior primary division of the second cervical nerve—Fig. 52 (8); and (*d*) the great occipital nerve from the posterior primary division of the second cervical nerve—Fig. 52 (4).

The *posterior auricular* (nervus auricularis posterior) is a small nerve which ascends upon the front of the mastoid process, immediately behind the ear, to supply the superficial muscles in this region. The guide to it is the posterior auricular artery, which lies in contact with it. After effecting a communication with the great auricular nerve, it divides into an auricular and an occipital division. The *auricular division* continues its upward course, and ends by supplying the retrahens auriculam and attollens auriculam muscles; the *occipital division* inclines backwards along the superior curved line of the occipital bone, and ends in the occipital belly of the occipito-frontalis muscle.

In searching for the posterior auricular nerve, the dissector will, in all probability, meet with the *mastoid branch* of the great auricular nerve, which ascends upon the mastoid process on a more superficial plane, and is distributed to the skin in this region.

The *small occipital nerve* (nervus occipitalis minor) will be discovered midway between the ear and the external occipital protuberance. It supplies numerous branches to the integument, and furnishes an *auricular twig* to the skin over the upper part of the cranial aspect of the ear. It communicates with the great auricular nerve on the one hand, and with the great occipital nerve on the other.

The *great occipital* (nervus occipitalis major) is a large nerve, and there will be little difficulty experienced in finding it, as it lies close to the occipital artery, a short distance external to the occipital protuberance. Its branches spread out over the back of the head, and supply a wide area of integument. It sends an *auricular twig* to the skin over the cranial aspect of the ear, and communicates with the small occipital nerve.

Blood Vessels of the Scalp.—Two small arteries, viz., the *frontal* and the *supra-orbital*, both branches of the ophthalmic, leave the orbit to supply the forehead. The former is associated with the supra-trochlear nerve, and the latter with the supra-orbital nerve. The *veins* corresponding to these arteries unite at the inner margin of the orbit to form the *angular vein*, which afterwards becomes the facial vein.

The *superficial temporal artery* (arteria temporalis superficialis) will be noticed ascending upon the temporal fascia, immediately in front of the ear. At a variable point above the zygoma it divides into its two terminal branches—viz., the anterior and posterior superficial temporal arteries.

The *anterior superficial temporal artery* (ramus frontalis) takes a tortuous course upwards and forwards to the forehead, and supplies numerous branches to the integument, muscles, and pericranium. Further, it anastomoses with the frontal and supra-orbital arteries, and with the corresponding vessel of the opposite side.

The *posterior superficial temporal artery* (ramus parietalis) inclines upwards and backwards, arching over the cranium above the auricle. It gives off numerous twigs to the parts in this region, and communicates with its fellow of the opposite side, and with the posterior auricular and occipital arteries.

The *posterior auricular artery* (arteria auricularis posterior) ascends in the angle between the cartilage of the ear and the mastoid process, and ends by dividing into two branches, named respectively the auricular and the mastoid. The *auricular branch* ascends under cover of the retrahens auriculam muscle, and supplies several twigs to the pinna, and, finally turning forwards above the auricle, it anastomoses with the posterior superficial temporal artery. The *mastoid branch* inclines backwards towards the occiput, where it communicates with the occipital artery.

The *posterior auricular vein* is a comparatively large vessel. It joins the posterior division of the temporo-maxillary vein, near the angle of the lower jaw, to form the external jugular vein.

The *occipital artery* (arteria occipitalis), which will be found a short distance to the outer side of the occipital protuberance, sends large tortuous branches over the back of the head. These anastomose with the corresponding vessels of the opposite side, and with the posterior auricular and posterior temporal arteries.

Temporal Fascia (fascia temporalis).—If the epicranial aponeurosis with the attached auricular muscles be now raised in the temporal region, a thin but distinct sheet of fascia will be observed proceeding from the upper temporal line of the parietal bone, in close relation to the deep surface of the attollens auriculam, to the pinna. When this is removed the strong temporal fascia which covers the temporal muscle is brought fully into view. Its connections will be studied at a later period.

Surgical Anatomy of the Scalp.—The close connexion between the three superficial layers of the scalp (viz., skin, superficial fascia, and epicranial aponeurosis), and the loose manner in which these are bound by areolar tissue to the pericranium, are points of great interest from a surgical point of view. When the scalp is wrenched from the head by machinery, or by any other means, the separation is effected in the plane of the areolar layer. The blood vessels, however, lie for the most part in the superficial fascia, and therefore large flaps of detached scalp can be replaced upon the denuded periosteum, and yet retain their vitality. It is a rare occurrence for a scalp flap to slough.

The scalp is richly supplied with blood vessels. Incised wounds in this region, therefore, bleed very profusely ; but, in addition to this, they bleed with more than usual persistence. This is accounted for by the dense character of the superficial fascia, and by the fact that the fibrous septa of this stratum adhere to the coats of the vessels, and prevent them from retracting freely when divided.

As will readily be understood, a collection of pus in the scalp will produce very different results, according to the position it occupies. If it is formed under the epicranial aponeurosis it spreads in all directions; indeed, it is only limited in front by the superciliary ridges of the frontal bone, and behind by the superior curved line of the occipital bone. If it is formed in the superficial fascia, it is confined to the point at which it originates.

.REMOVAL OF THE BRAIN.

On the second day after the subject has been placed on the table, the two dissectors of the head and neck should, in conjunction with each other, proceed to remove the brain.

Dissection.—The head being supported upon a block, an incision is made along the middle line of the head, through the epicranium, the subjacent areolar tissue, and the pericranium, from the root of the nose in front, to the external occipital protuberance behind. This must be done boldly, so as to divide everything right down to the bone. With a series of sharp strokes with the handle of the scalpel, the pericranium on each side can easily be turned outwards, so as to leave the bone perfectly bare. Observe, however, that although the pericranium is loosely attached over the surface of the various bones of the vault, it is firmly attached along the lines of the cranial sutures by processes that dip in between the bones, so as to separate their edges. On reaching the temporal ridges, push the knife through the attachment of the temporal fascia, so that the blade lies between the temporal muscle and the bone. Then run the knife backwards and forwards, so as to thoroughly divide the attachment of the fascia to the ridge. When this is done on either side, the fascia and muscle can be easily raised together from the temporal fossa, and thrown down over the ear with the remains of the scalp.

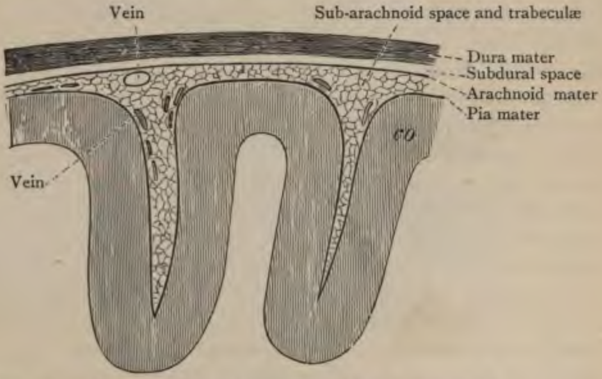

FIG. 53.—Diagrammatic section through the Meninges of the Brain. (Schwalbe.)

co. Grey matter of cerebral convolutions.

The dissectors should next obtain a saw, a chisel, and a mallet, and proceed to remove the calvaria. The line along which the saw is to be used may be marked out on the skull by encircling it with a piece of string, and then marking the cranium with a pencil along the line of the string. In front, the cut should be made fully three-quarters of an inch above the margins of the orbits; behind, it should be carried round at the level of a point midway between the lambda[1] and the external occipital protuberance. The saw should only be used to divide the outer table of the skull. When the diploe is reached, which will be observed by the sawdust becoming red and moist, the saw should be abandoned. The hammer and chisel are now brought into requisition, and by these the inner table can readily be split along the line in which the outer table of the cranium is divided. By insinuating the hook at the end of the cross-bar of the chisel into the fissure in front, the skull-cap can be forcibly wrenched off.

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[1] The term "lambda" signifies the apex of the occipital bone, or the point at which the sagittal and lambdoidal sutures meet.

Dura Mater (dura mater encephali).—The brain is clothed by three distinct membranes, which are termed the *meninges*. These are from without inwards—(1) the dura mater; (2) the arachnoid mater; and (3) the pia mater.

When the skull-cap is detached, the outer surface of the dura mater, as it covers the upper surface of the cerebral hemispheres, is exposed. It is rough, and dotted over with bleeding points. If a portion were placed in water, its roughness would become still more manifest, and be seen to be due to a multitude of fine fibrous and vascular processes, by which it is connected with the deep surface of the bones. These have necessarily been torn asunder in the removal of the skull-cap. The bleeding points are most numerous along the middle line, or, in other words, along the line of the superior longitudinal sinus; and if the handle of the knife be run from before backwards, so as to make pressure along this line, a considerable quantity of blood will ooze out. This shows that a number of small veins from the cranial bones have been ruptured. The degree of adhesion between the dura mater and the inner surface of the cranial bones varies in different subjects and in different localities. In all cases it is strongly adherent along the lines of the sutures; and, further, it is much more firmly attached to the base than the vault of the cranium. In the child—indeed, as long as the bones of the cranium are growing—it is more adherent than in the adult; and it is also more firmly bound to the bone in old age.

The dissector should now clean the outer surface of the dura mater with a sponge. He will then recognise the *middle meningeal artery* upon each side, ascending in the substance of the membrane, and sending off its branches in a widely arborescent manner. It stands out in bold relief from the membrane in which it ramifies; and if the skull-cap be examined, its inner surface will be observed to be deeply grooved by its ramifications. The meningeal arteries, as the name might lead one to imagine, are not intended for the supply of the membrane alone. They must also be looked upon as the nutrient vessels of the inner table and diploe of the cranial bones.

The *Pacchionian bodies* (granulationes arachnoidales), which are almost invariably present, and which are as a rule best marked in old subjects, will attract notice at this stage. They are small granular bodies, ranged in clusters on either side of the superior longitudinal sinus, into which many of them protrude (Fig. 54). As a general rule, they are most evident towards the hinder part of the parietal region. At first sight these bodies appear to be protrusions from the dura mater, but this is not the case. They spring from the arachnoid mater, and are enlargements of the normal villi of this membrane.

The relation which the Pacchionian bodies present to the dura mater is somewhat intricate. When they project into the superior longitudinal sinus they push before them a thin covering continuous with the floor of the sinus, so that in no sense can they be said to pierce its wall. On either side of the superior longitudinal sinus there are a number of irregular spaces or intervals which communicate with the sinus either by a small aperture or a narrow channel. These recesses are termed *parasinoidal sinuses* or *lacunæ laterales*, and the independent meningeal veins, and some of the diploic veins, pour their blood into them. Pacchionian bodies push themselves into the parasinoidal sinuses from below in such a manner that they receive a complete covering by the invagination of the floor. Nor does the bone escape. As the Pacchionian bodies enlarge, they cause absorption of the cranial wall, and small pits are hollowed out on its deep surface for their reception. The superficial walls of the lacunæ—very much thinned—line these depressions in the calvaria.

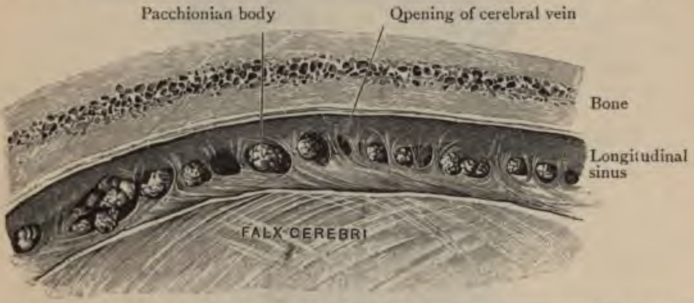

FIG. 54.—Mesial section through the Frontal Bone and corresponding part of the Longitudinal Blood Sinus. The Pacchionian bodies are seen protruding into the sinus. (Enlarged.)

Two Layers of the Dura Mater.—Having learned these preliminary details from an examination of the outer surface of the dura mater, as it clothes the upper surface of the cerebral hemispheres, the student is in a position to understand that this membrane does not belong entirely to the brain. It performs a double function: (1) it acts as an internal periosteum to the bones forming the cranial cavity;

and (2) it gives support to the different parts of the brain. Consequently, it consists of two strata, which, in most localities, are firmly adherent, but which nevertheless can usually be easily demonstrated in the dissecting-room. These strata may very appropriately be termed the *endocranial* and the *supporting layers*. Along certain lines these two layers separate from each other. In some cases they separate so as to form channels, termed *blood sinuses* (sinus duræ matris), for the conveyance of venous blood; in other cases they separate in order that the inner supporting layer may form strong folds or partitions, which run in between the various parts of the brain. By these latter the cranial cavity is divided into compartments communicating freely with each other, and each holding a definite subdivision of the brain (Fig. 57).

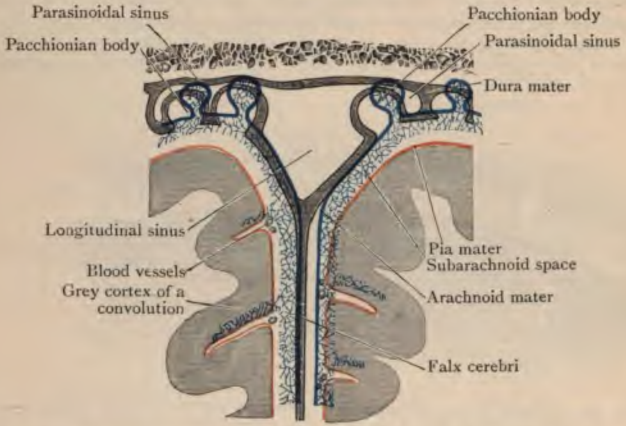
Parasinoidal sinus
Pacchionian body
Pacchionian body
Parasinoidal sinus
Dura mater
Longitudinal sinus
Blood vessels
Grey cortex of a convolution
Pia mater
Subarachnoid space
Arachnoid mater
Falx cerebri

FIG. 55.—Diagram of a coronal section through the middle portion of the cranial vault and subjacent brain to show the membranes of the brain and the Pacchionian bodies.

Dissection.—These points must now be verified. Begin by tilting the head forwards. Support it in this position, and make two incisions through the dura mater in an antero-posterior direction—one on each side of the superior longitudinal sinus, and along its whole length. From the mid-point of each of these incisions another cut must be made through each lateral portion of the dura mater downwards to the cut margin of the skull immediately above the ear (Fig. 56). The dura mater covering the upper aspect of the brain is thus divided into a central strip containing the superior longitudinal sinus and four triangular flaps. The flaps should now be turned downwards over the cut margin of the skull, and in this position they preserve the brain during its removal from laceration by the sharp bony edge.

Subdural Space (cavum subdurale).—This is the term which is applied to the interval between the dura mater and the arachnoid mater—Figs. 53 and 55. It contains a very small quantity of serous fluid which moistens the opposed surfaces of these membranes. A striking contrast between the two surfaces of the dura mater will be observed. The superficial surface, as we have noted, is rough and flocculent. The deep surface, which is turned towards the subdural space, is smooth, polished, and glistening.

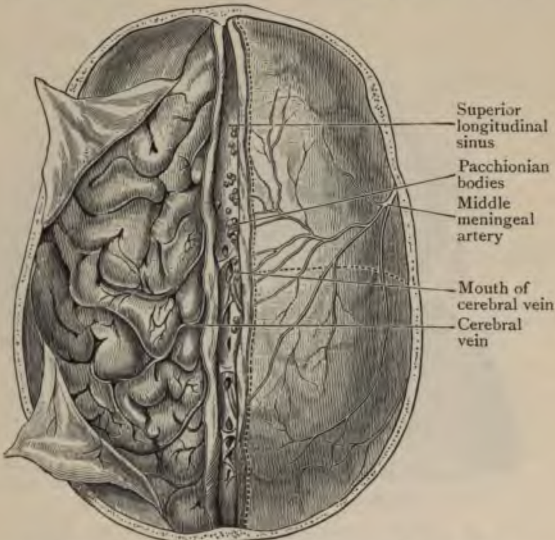

FIG. 56.—The Dura Mater and the Superior Longitudinal Sinus, etc. The lines along which the dura mater should be incised in removing the brain are indicated by dotted lines on the right side.

The **cerebral veins** returning the blood from the surface of the cerebral hemispheres will be seen shining through the arachnoid. They are lodged for the most part in the sulci between the convolutions, and run upwards to the middle line. Reaching the superior longitudinal sinus they are suddenly directed forwards, and lie against the wall of the sinus for some distance before they open into it (Fig. 56).

Superior Longitudinal Sinus (sinus sagittalis superior).—Open into this venous channel by running the knife through its upper wall from behind forwards (Figs. 56 and 57). It begins in front at the crista galli of the ethmoid bone, where it not unfrequently communicates with the veins in the nasal cavity through the foramen cæcum, and it extends backwards, grooving the cranial vault in the middle line, to the internal occipital protuberance, on the right aspect of which it becomes continuous with the right lateral sinus. Its lumen, which is triangular in cross-section, is very small in front, but expands greatly as it is followed backwards. The mouths of the superior cerebral veins are observed opening into it. These veins pour their blood into it in a direction contrary to that in which the blood flows within the channel. The terminal portions of the veins are directed from behind forwards, whilst the blood in the sinus flows from before backwards. Opening into the sinus are also

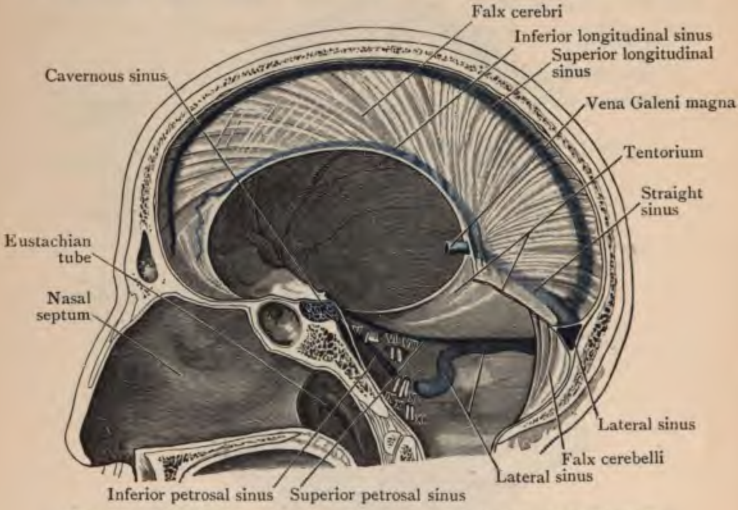
Falx cerebri
Inferior longitudinal sinus
Superior longitudinal sinus
Cavernous sinus
Vena Galeni magna
Tentorium
Straight sinus
Eustachian tube
Nasal septum
Lateral sinus
Falx cerebelli
Lateral sinus
Inferior petrosal sinus
Superior petrosal sinus

FIG. 57.—Sagittal section through the Skull a little to the left of the mesial plane to show the processes of Dura Mater.

V. Fifth cranial nerve.
VII. Facial nerve.
VIII. Auditory nerve.
IX. Glossopharyngeal nerve.
X. Vagus nerve.
XI. Spinal accessory nerve.
XII. Hypoglossal nerve.

the mouths of the *lacunæ laterales*, whilst bulging into it on either side are as a rule numerous *Pacchionian bodies*. The channel is crossed at its inferior angle by a number of minute bands. These receive the name of *chordæ Willisii*.

Falx Cerebri (Fig. 57).—This is a sickle-shaped reduplication of the supporting layer of the dura mater, which descends in the mesial plane between the two cerebral hemispheres. In order to expose it, the cerebral veins, as they open into the superior longitudinal sinus, must be divided, and the hemisphere gently pulled outwards. In front, the falx cerebri is narrow, and attached to the crista galli of the ethmoid bone. As it is followed backwards, it increases in breadth, and behind, it is attached in the middle line to the upper surface of the tentorium cerebelli. The anterior part of the falx is frequently cribriform, and is sometimes perforated by apertures to such an extent that it almost resembles lace-work. Along each border it splits into two layers so as to enclose a blood-sinus. Along its upper convex margin runs the *superior longitudinal sinus*; along its concave free border courses the much smaller *inferior longitudinal sinus*; whilst along its attachment to the tentorium is enclosed the *straight sinus*. Its inferior concave margin overhangs the corpus callosum, with which, however, it is not in contact, except, perhaps, to a very slight extent, behind.

Removal of the Brain.—The dissectors should now proceed to remove the brain. Having divided the attachment of the falx cerebri to the crista galli, pull it backwards. Next, removing the block upon which the head rests, and supporting the occiput and posterior lobes of the brain with the left hand, let the head drop well backwards. In all probability, the frontal lobes will fall away by their own weight from the anterior fossa of the base of the cranium, and perhaps carry with them the olfactory bulbs. Should they remain in position, however, gently raise them with the fingers, and separate, at the same time, with the handle of the knife the olfactory bulbs from the cribriform plate of the ethmoid. In raising the olfactory bulbs, the minute *olfactory nerves* which spring from them and perforate the cribriform plate of the ethmoid bone are torn across. The large round and white *optic nerves* (second pair of cranial nerves) now come into view as they leave the cranium through the optic foramina. When these are divided, the *internal carotid arteries* will be exposed, and between them, in the mesial plane, the *infundibulum*, a hollow conical process which connects the pituitary body with the tuber cinereum—a lamina of grey matter on the base of the brain. It will be noticed that the infundibulum lies slightly behind the internal carotid arteries.[1] Sever in turn each of these structures. We then come upon the *oculo-motor nerves* (third pair of cranial nerves), which must be dealt with in like manner. Observe first, however, that they lie behind, and external to the carotid trunks. The dissector should now see upon either side the anterior extremity of the inner free margin of the tentorium cerebelli as it passes forward to be attached to the anterior clinoid process. Pressing this outwards with the point of the knife, the minute *trochlear nerve* (fourth cranial nerve) will be brought into view. It lies under shelter of the free border of the tentorium, and should be divided at this stage. The head must in the next place be turned forcibly round, so that the face is directed over the left shoulder. On raising the posterior part of the right cerebral hemisphere with the fingers, it will be observed to rest upon the tentorium cerebelli—a broad horizontal process of dura mater, which intervenes between it and the cerebellum. Divide the tentorium along its attached border, and take care in doing this not to injure the subjacent cerebellum. When the division is effected, push the tentorium backwards out of the way with the point of the knife. Now turn the head so as to bring its left side uppermost, and treat the tentorium on this side in the same manner. The two parts of the *trigeminal nerve* (fifth cranial nerve) perforating the dura mater near the apex of the petrous portion of the temporal bone; the *abducent nerve* (sixth cranial nerve) piercing the dura mater behind the dorsum sellæ of the sphenoid bone; the *portio dura* or *facial nerve*, the *pars intermedia*, and the *portio mollis* or *auditory nerve* disappearing into the internal auditory meatus; the *glosso-pharyngeal*, the *vagus*, and the *spinal accessory nerves* leaving the skull through the jugular foramen; and the two slips of the *hypoglossal nerve* piercing the dura mater over the anterior condyloid foramen, will each in turn come into view upon either side, and each must be divided in succession.

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[1] In dividing the cranial nerves, it is well to cut them close to the point where they pierce the dura mater on one side of the body, and close to the brain on the other side.

In the case of the three nerves passing out of the cranium through the jugular foramen, the dissector should endeavour to leave the spinal accessory of the right side intact within the cranium, by dividing its roots of origin from the medulla, whilst on the other side he should remove it with the brain. This nerve will be readily recognised from its ascending from the spinal canal into the cranial cavity through the foramen magnum. It is only necessary now for the dissector to thrust the knife into the spinal canal, and divide the vertebral arteries as they turn forwards upon the upper part of the spinal cord, and then sever at a lower level the spinal cord, the spinal accessory nerve of the left side, and the roots of the first pair of spinal nerves. By letting the head fall well backwards, and gently dislodging the medulla and cerebellum, the whole brain can be removed. The veins of Galen, as they pass from the interior of the brain to enter the straight sinus, are ruptured by this proceeding.

Preservation of the Brain.—In order that the brain may be studied to best advantage, it is necessary that it should be subjected to some hardening reagent. Methylated spirit, with a small amount of formalin (4 per cent) added to it, gives the best results. The dissector must obtain a vessel large enough to hold the brain, and, at the same time, allow the hardening reagent to surround and cover it completely. It must likewise be provided with an accurately fitting lid to prevent evaporation. A small amount of cotton wadding should be arranged at the bottom of the vessel, in the form of a nest, so as to preserve, as far as possible, the natural form of the brain. The brain should be placed upon this, with its base or lower surface uppermost, and the meninges of the base should be torn across, so as to give free admission to the fluid. It is well also to raise the cerebellum slightly from the cerebrum by means of a small pad of wadding, and it is advantageous to tear across the arachnoid at the back of the corpus callosum.

It is best to defer the study of the brain until the dissection of the head and neck is completed.

Dura Mater at the Base of the Cranium.—The dissector has observed that the dura mater can, as a rule, be easily separated from the under surface of the cranial vault. He would find it impossible to raise it in like manner from the base of the cranium. It is closely adherent to the crista galli, to the posterior margins of the lesser wings of the sphenoid, to the posterior clinoid processes, to the petrous portions of the temporal bones, to the basilar process of the occipital bone, and around the margin of the foramen magnum. Another cause of its close adhesion in this locality is, that it gives sheaths to the cranial nerves, and passes out of the cranium through the basal foramina to become continuous with the periosteum on the external surface of the skull. So close, indeed, is the union between the dura mater and the base of the cranium, that it would require maceration to effect a complete separation.

Partitions of Dura Mater.—The dura mater gives off, as we have already seen, processes which act as partial partitions within the cranial cavity. These are four in number, viz.:—

1. The falx cerebri (which has already been studied).
2. The tentorium cerebelli.
3. The falx cerebelli.
4. The diaphragma sellæ.

Tentorium Cerebelli (Fig. 57 and Fig. 58).—This is a large crescentic fold of dura mater which constitutes a membranous roof for the posterior fossa of the cranium, and at the same time forms a partition between the posterior lobes of the cerebrum and the cerebellum. It is not horizontal. It is accurately applied to the upper surface of the cerebellum. Its highest point, therefore, is in front, in the mesial plane, and from this it gradually slopes downwards to its attached border. Except in cases where formalin has been injected into the cranial cavity during the preservation of the subject, only an imperfect idea of the natural appearance of the tentorium can be obtained, seeing that its connections have been severed in the removal of the brain. Before it is disturbed it is tense, and this tension is due to its connection with the falx cerebri. These two processes of dura mater are mutually dependent on each other in this respect—divide one, and both become relaxed.

The *posterior border* of the tentorium is convex, and is attached to the horizontal ridge which marks the deep surface of the occipital bone. Beyond this, on each side, it is fixed to the posterior inferior angle of the parietal bone, and then forwards along the upper border of the petrous portion of the temporal bone. From the internal occipital protuberance to the postero-inferior angle of the parietal bone this border encloses the *lateral blood sinus*, whilst along the upper border of the petrous bone it encloses the *superior petrosal sinus*. The *anterior border* of the tentorium is sharp, free, and concave, and forms, with the dorsum sellæ of the sphenoid, an oval opening (incisura tentorii), within which the mesencephalon is placed. Beyond the apex of the petrous portion of the temporal bone the two margins of the tentorium cross each other like the limbs of the letter X; the free margin is carried forwards to be attached to the anterior clinoid process, whilst the attached border is continued inwards to be fixed to the posterior clinoid process (Fig. 59).

Falx Cerebelli.—This is a small falciform fold of dura mater placed under the tentorium, which extends forwards in the mesial plane from the internal occipital crest (Fig. 58). It occupies the notch which separates the two lateral hemispheres of the cerebellum posteriorly. Above, it is attached to the posterior part of the under surface of the tentorium. Its anterior border is free; whilst inferiorly, it bifurcates into two small diverging ridges, which gradually fade away as they are traced forwards on either side of the foramen magnum.

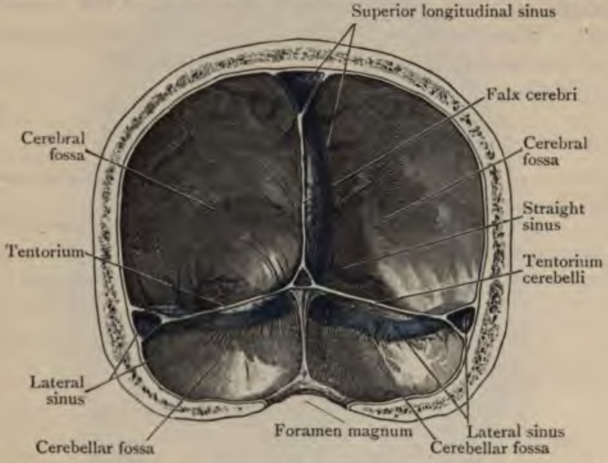
Superior longitudinal sinus
Falx cerebri
Cerebral fossa
Cerebral fossa
Straight sinus
Tentorium
Tentorium cerebelli
Lateral sinus
Foramen magnum
Lateral sinus
Cerebellar fossa
Cerebellar fossa

FIG. 58.—Coronal section through the Cranial Cavity in a plane which passes through the hinder part of the foramen magnum. The posterior part of the cranial cavity, from which the brain has been removed, is depicted.

Diaphragma Sellæ.—This is a small circular fold of the inner layer of the dura mater which forms a roof for the sella turcica. A small opening is left in its centre for the passage of the infundibulum. An almost complete case of dura mater is thus formed for the pituitary body.

Cranial Nerves.—The dissector should now turn his attention to the cranial nerves, and study the manner in which they leave the cranial cavity. Each nerve carries out with it a covering derived from each of the three membranes of the brain. In the case of the optic nerve these remain distinct; but in all the others the sheath derived from the arachnoid very soon disappears.

Begin by examining the cribriform plate of the ethmoid. From this the olfactory bulb has been displaced in the removal of the brain. About twenty minute *olfactory nerves* (nervi olfactorii) proceed from the under surface of the bulb and descend into the nose through the holes in the cribriform plate. These have been ruptured close to their origin, but in all probability traces of them will be observed.

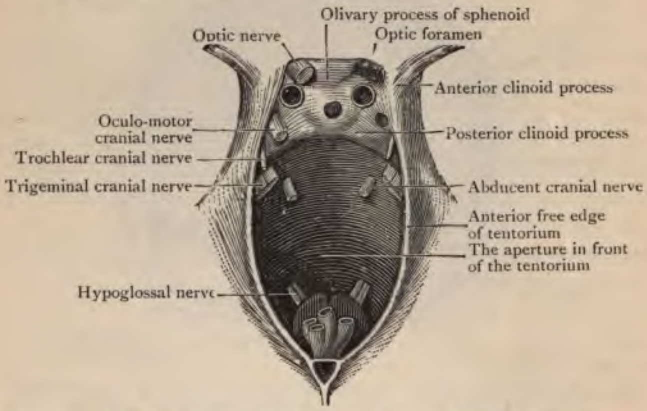
Olivary process of sphenoid
Optic nerve
Optic foramen
Anterior clinoid process
Oculo-motor cranial nerve
Posterior clinoid process
Trochlear cranial nerve
Trigeminal cranial nerve
Abducent cranial nerve
Anterior free edge of tentorium
The aperture in front of the tentorium
Hypoglossal nerve

FIG. 59.—Aperture between the Dorsum Sellæ and the anterior concave free margin of the Tentorium. (Hirschfeld and Leveillé.)

The *second* or *optic nerve* (nervus opticus)—Figs. 59 and 60—will be seen entering the orbit through the optic foramen. It is accompanied by the ophthalmic artery, which lies below it. The student should note the strong loose sheath of dura mater which envelops the nerve.

The *third* or *oculo-motor nerve* (nervus oculomotorius)—Figs. 59 and 60—is a firm cord-like nerve, which pierces the dura mater in front of the posterior clinoid process, within a triangular area indistinctly marked out by the intersection of the margins of the tentorium, as they pass to be attached to the clinoid processes. The nerve enters the wall of the cavernous sinus, in which it will be afterwards traced.

The minute thread-like *fourth* or *trochlear nerve* (nervus trochlearis)—Figs. 59 and 60—also enters the wall of the cavernous sinus, to gain which it perforates the dura mater a short distance behind, and to the outer side of the third nerve, but within the same triangular area. Its aperture of exit lies under shelter of the free margin of the tentorium.

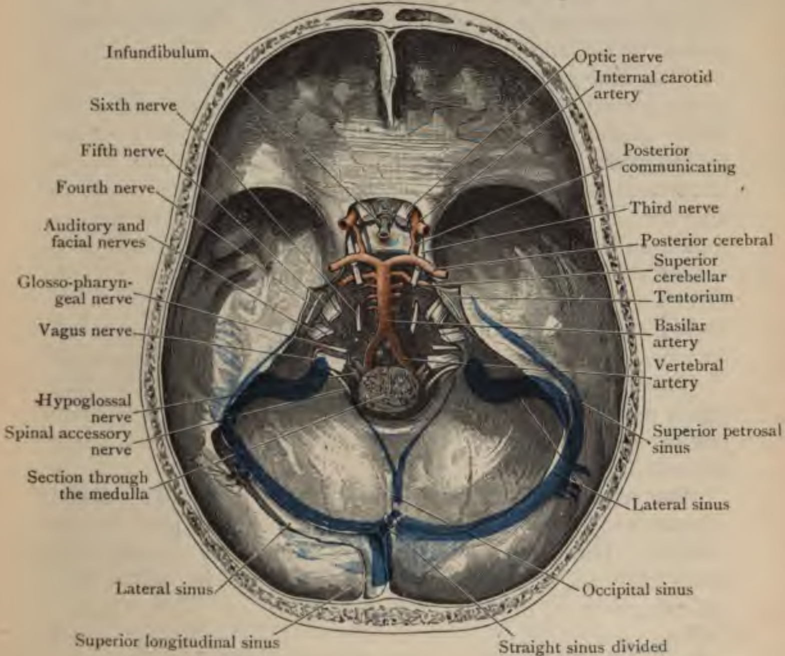
Infundibulum
Sixth nerve
Fifth nerve
Fourth nerve
Auditory and facial nerves
Glosso-pharyngeal nerve
Vagus nerve
Hypoglossal nerve
Spinal accessory nerve
Section through the medulla
Lateral sinus
Superior longitudinal sinus
Optic nerve
Internal carotid artery
Posterior communicating
Third nerve
Posterior cerebral
Superior cerebellar
Tentorium
Basilar artery
Vertebral artery
Superior petrosal sinus
Lateral sinus
Occipital sinus
Straight sinus divided

FIG. 60.—Floor of the Cranium after the removal of the Brain and the Tentorium Cerebelli. The blood vessels forming the circle of Willis have been left in place.

The *fifth* or *trigeminal nerve* (nervus trigeminus)—Figs. 59 and 60—is composed of two parts—viz., a large, soft, sensory portion, consisting of loosely connected funiculi, and a small, firmer, motor portion, which lies upon the inner or deep surface of the sensory part. They can generally be easily distinguished, and both pierce the dura mater at the apex of the petrous portion of the temporal bone, and under the anterior extremity of the tentorium.

The *sixth* or *abducent nerve* (nervus abducens)—Figs. 59 and 60—is a small, round nerve, which disappears through the dura mater at the lower and outer part of the dorsum sellæ, and enters the wall of the cavernous sinus.

The *auditory nerve* (nervus acusticus), the *facial nerve* (nervus facialis) (Fig. 60), and the small *pars intermedia* (nervus intermedius), all enter the auditory meatus, where the pars intermedia joins the facial nerve. They are accompanied by the auditory artery.

The *glosso-pharyngeal* (nervus glossopharyngeus), the *pneumogastric* (nervus vagus), and the *spinal accessory* (nervus accessorius) pierce the dura mater over the internal jugular foramen in the order in which they have been named, from before backwards (Fig. 60). The glosso-pharyngeal has a separate aperture of exit in the dura mater, and therefore receives a separate sheath of dura mater, whilst the vagus and spinal accessory have a common aperture, and a common sheath of both arachnoid and dura mater. They all leave the skull through the middle compartment of the jugular foramen. The spinal accessory has already been noticed ascending from the spinal canal.

The *hypoglossal nerve* (nervus hypoglossus) pierces the dura mater opposite the anterior condyloid foramen at two separate points, in the form of two distinct slips (Fig. 60). These unite in the foramen.

Venous Blood Sinuses (sinus duræ matris).—The blood sinuses which traverse the dura mater should next be examined. Each should be opened in turn by running the knife through the dura mater which forms its wall. The following is a list of these sinuses :—

1. Superior longitudinal.
2. Inferior longitudinal.
3. Straight.
4. Occipital.
5. Cavernous.
6. Spheno-parietal.
7. Circular.
8. Superior petrosal.
9. Inferior petrosal.
10. Basilar.
11. Lateral.

As already pointed out, the cranial blood sinuses are in some cases formed by a separation of the two layers of the dura mater; in other cases they are formed in the reduplications of the inner layer of the dura mater which constitute the partitions. The channels thus constituted are lined by a smooth membrane, which is continuous with the internal coat of the veins.

Torcular Herophili (confluens sinuum).—The *superior longitudinal sinus* has been already examined, except at the point where it terminates. The dissector should notice that as it descends upon the deep surface of the occipital bone, it, as a rule, inclines slightly to one or other side of the mesial plane, more usually to the right side, and in this way it terminates upon one side of the internal occipital protuberance. Here it is somewhat dilated, and then turns suddenly outwards, to form the lateral sinus of that side. This expansion of the superior longitudinal sinus is termed the *torcular Herophili*, and it communicates by means of a transverse channel, which crosses the front of the internal occipital protuberance, with the commencement of the lateral sinus of the opposite side.

Inferior Longitudinal Sinus (sinus sagittalis inferior)—Fig. 57.—This small sinus runs backwards in the lower free border of the falx cerebri. It begins at a variable point behind the crista galli, and ends posteriorly at the anterior free edge of the tentorium, where it pours its blood into the straight sinus.

Straight Sinus (sinus rectus).—This venous channel extends backwards and downwards in the mesial plane, from the anterior free edge of the tentorium to the internal occipital protuberance. Its course corresponds with the attachment of the posterior broad end of the falx cerebri to the upper surface of the tentorium. Indeed, it is formed by the opening out of the two layers of the falx on the upper surface of the tentorium. At its anterior extremity it receives the blood from the inferior longitudinal sinus and the vena magna Galeni. The latter returns the blood from the interior of the cerebrum, and its ruptured end may be noticed at the point where it enters the straight sinus (Fig. 57). At the internal occipital protuberance, the straight sinus bends suddenly outwards, in a direction opposite to that taken by the superior longitudinal sinus, and it forms the lateral sinus of that side. A few small cerebellar veins pour their blood into the straight sinus.

Occipital Sinus (sinus occipitalis)—Fig. 60.—This is a minute blood-channel, which is placed between the layers of the falx cerebelli. Above, it opens into the *torcular Herophili*, whilst below, at the foramen magnum, it bifurcates, and the two divisions not infrequently run forwards to join the lower end of the lateral sinus upon either side. Sometimes the occipital sinus is double throughout its whole course.

Lateral Sinuses (sinus transversi)—Figs. 57 and 58.—These are two in number—one on each side. They are variable in their mode of origin, but, as we have noted, the right lateral sinus is commonly formed by the superior longitudinal sinus, whilst the left is formed by the straight sinus. They commence one upon either side of the internal occipital protuberance, and communicate with each other by a transverse channel of variable width, which passes in front of this bony prominence. The sinus which represents the continuation of the superior longitudinal sinus is generally considerably larger than the other. From the occipital protuberance, each lateral sinus passes at first outwards and upwards, and grooves the occipital bone and the inferior angle of the parietal bone along the attached border of the tentorium. Reaching the temporal bone, it is joined by the superior petrosal sinus; and leaving the tentorium, it suddenly curves downwards and inwards, in the deep furrow upon the mastoid portion of the temporal bone, and the jugular process of the occipital bone. Lastly, it turns forwards and disappears into the posterior compartment of the jugular foramen, where it terminates in the bulb of the internal jugular vein. In this course the lateral sinus describes an arch (Birmingham) with the convexity upwards, the highest point of which, as a rule, corresponds with the posterior inferior angle of the parietal bone.

Venous *tributaries* which come from the cerebellum, back part of the cerebrum, and from the diploe of the cranial bones, may be noticed opening into the lateral sinus.

Two large and important *emissary veins* connect it with the veins of the scalp, and allow its blood, when it is overcharged, to drain partly away in this direction. These are the *mastoidal vein* (emissarium mastoideum), joining it through the mastoid foramen, and the *posterior condyloid vein* (emissarium condyloideum), which joins it through the posterior condyloid foramen.

Cavernous Sinus (sinus cavernosus)—Fig. 57.—It is not advisable that the dissector should open the cavernous sinus at this stage, on account of the various nerves which pass forwards in its walls to the orbit, and which are best studied with the parts in that cavity. He should simply note, therefore, at present, that this sinus lies upon the side of the body of the sphenoid bone.

Circular Sinus (sinus circularis). — The circular sinus is formed of two transverse channels (the anterior and the posterior intercavernous sinuses) which connect the cavernous sinuses, and lie one in front and the other behind the infundibulum of the pituitary body.

Petrosal Sinuses—Fig. 57.—The petrosal sinuses drain the blood from the posterior end of the cavernous sinus. They are two in number on each side—viz., superior and inferior. The *superior petrosal sinus* (sinus petrosus superior) runs along the superior border of the petrous portion of the temporal bone, and joins the lateral sinus. The *inferior petrosal sinus* (sinus petrosus inferior) is the larger of the two, but has a shorter course. It passes backwards and outwards in the groove between the basilar process of the occipital bone and the inferior margin of the petrous portion of the temporal bone. It leaves the cranial cavity by passing through the anterior compartment of the jugular foramen, and ends by joining the commencement of the internal jugular vein.

Basilar Sinus (plexus basilaris). — The basilar sinus is not a single channel, but a plexus of minute sinuses which permeate the dura mater over the basilar process of the occipital bone. It connects the two inferior petrosal sinuses, and communicates below with the anterior intraspinal veins.

Spheno-Parietal Sinus (sinus alæ parvæ).—The spheno-parietal sinus is a minute blood channel which runs inwards on each side under shelter of the lesser wing of the sphenoid bone. Externally it commences in one of the meningeal veins, whilst internally it pours its blood into the fore-part of the cavernous sinus. Owing to its position, this sinus is somewhat difficult to demonstrate.

Petro-Squamous Sinus.—Very frequently a small blood channel will be noticed running backwards along the petro-squamous fissure, in the angle between the squamous and petrous parts of the temporal bone. It is of importance in connection with the surgery of the middle ear.

Arteries entering the Cranial Cavity.—The student has now examined the various channels by means of which the venous blood is drained out of the cranial cavity. He should next examine the arteries which introduce the blood into this cavity. These are—

1. The vertebral arteries.
2. The internal càrotid arteries.
3. The meningeal arteries.

Vertebral and Internal Carotid Arteries.—These vessels carry blood for the supply of the encephalon and the parts within the orbit. The *internal carotid artery* will be observed piercing the dura mater immediately behind, and to the inner side of the anterior clinoid process. At this point it gives off its ophthalmic branch which accompanies the optic nerve through the optic foramen, and immediately beyond this the internal carotid trunk has been severed in the removal of the brain. The *vertebral artery* will be observed piercing the dura mater immediately below the foramen magnum, through which it enters the cranium. Here it passes between the highest denticulation of the ligamentum denticulatum and the hypoglossal nerve. It also has been divided close to its point of entrance.

Meningeal Arteries.—These are the nutrient arteries of the dura mater, and the inner table and diploe of the cranial bones. They are derived from a great number of different sources, but the only one of any size is the *middle meningeal*, which comes from the internal maxillary artery. The others are small twigs, and, except in a well-injected subject, will not be easily made out. They are:—(1) *anterior meningeal* from the anterior ethmoidal artery; (2) the *small meningeal* from the internal maxillary artery; (3) some small branches from the ascending pharyngeal, occipital, and vertebral arteries.

The *middle meningeal artery* (arteria meningea media), a branch of the internal maxillary artery, enters the cranium through the foramen spinosum of the sphenoid, and divides upon the deep surface of the great wing of that bone into two large terminal branches. Of these, the anterior branch ascends upon the great wing of the sphenoid, and the anterior inferior angle of the parietal bone, grooving both deeply, whilst the posterior branch turns backwards upon the squamous portion of the temporal bone. The branches which proceed from these trunks spread out widely and occupy the arborescent grooves on the deep surface of the cranial vault.

Two *veins* accompany the middle meningeal artery. They pass through the foramen spinosum and unite in a common trunk which joins the pterygoid plexus.

The *anterior meningeal artery* (arteria meningea anterior) proceeds from the anterior ethmoidal artery as it lies on the cribriform plate of the ethmoid bone, along with the nasal nerve. It supplies a limited area of dura mater and bone in the anterior fossa of the cranium.

The *small meningeal artery* (ramus meningeus accessorius) is somewhat inconstant, and not infrequently springs from the middle meningeal. It enters the cranium through the foramen ovale, but it should not be looked for at the present stage, as it is best examined along with the Gasserian ganglion and the three divisions of the trigeminal nerve.

The *meningeal branches from the ascending pharyngeal artery* are the terminal twigs of this vessel, and enter the cranium through the foramen lacerum medium, through the jugular foramen, and through the anterior condyloid foramen. The branch which passes through the jugular foramen is the largest.

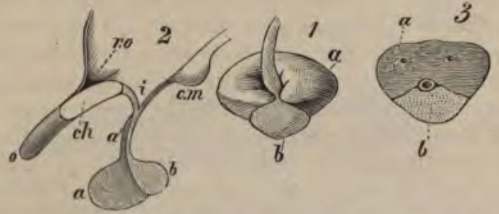

FIG. 61.—1, Pituitary body; 2, in mesial section; 3, in horizontal section. (Schwalbe.)

a. Anterior lobe.
b. Posterior lobe.
cm. Corpus mammillare.
i. Tuber cinereum.
ch. Optic commissure in section.
ro. Optic recess of the third ventricle.
o. Optic nerve.
a'. Infundibulum with projection from anterior lobe upwards in front of it.

The *meningeal branches of the occipital and vertebral arteries* are small. The former enters through the jugular foramen, whilst the latter gains admittance to the cranium through the foramen magnum, and is distributed in the posterior cranial fossa.

The *meningeal veins* may be regarded as being arranged in two sets: one set consists of small channels which pour their blood into the blood sinuses; the other set is composed of small veins which accompany the meningeal arteries and carry their blood to venous trunks on the exterior of the cranium.

Pituitary Body (hypophysis cerebri)—Fig. 61.—The overhanging margin of the diaphragma sellæ should be freely cut in two or three places, and the pituitary body carefully dislodged from the sella turcica of the sphenoid bone. If this be done successfully, the body will be seen to be an oval structure, slightly flattened from above downwards, and with its long axis directed transversely. Further, it may be noticed to consist of a large anterior lobe, and a smaller posterior lobe. The former of these is hollowed out behind so as to form a concavity for the lodgment of the latter. If a vertical section be made through the body, the line of separation between the two lobes is very distinct. The infundibulum which connects the pituitary body with the tuber cinereum of the brain is continued into the posterior lobe, and is in no way structurally continuous with the larger anterior lobe, although a surface inspection of the body is apt to give the dissector that impression (Fig. 61, 1). Thus, even in the adult, we have a clue to the different modes of development of the two lobes. The posterior lobe is derived from the brain, whilst the anterior lobe is an offshoot from the primitive buccal cavity.

The dissectors of the head and neck must now prepare for the changing of the position of the subject. Some tow, or a sponge, soaked in a mixture of methylated spirit and carbolic acid (to which a little formalin may be added with advantage), should be introduced into the cranial cavity. The skull-cap should then be replaced and retained in position by bringing the scalp flaps over it, and stitching them accurately together. It is a common practice with students, when the scalp has been dissected and the brain removed, to throw the skull-cap aside. This proceeding cannot be too strongly condemned, because the contour of the head is then lost, and in the subsequent dissection false conceptions are apt to be formed.

DORSAL ASPECT OF THE TRUNK.

On the third day after the subject has been placed in the dissecting-room its position is changed. It is now laid on its face, with its chest and pelvis supported by blocks. The head should be allowed to fall well over the end of the table (Fig. 62). During the four days that the body is allowed to lie in this position, the dissectors of the head and neck have to dissect the dorsal aspect of the cervical, thoracic, lumbar, and sacral regions, and, in addition, remove the spinal cord.

The dissectors of the upper limbs take part in this dissection. It is their duty to dissect the superficial and deep fasciæ in the thoracic and lumbar regions, and also those structures which connect the limb to the trunk posteriorly. To them, therefore, belong the trapezius muscle below the seventh cervical spine, the latissimus dorsi and the rhomboid muscles, together with their vessels and nerves of supply. The levator anguli scapulæ and the omo-hyoid are to be regarded as common property. The dissectors of the upper limbs are allowed two days to complete this work.

During the first two days allowed for the dissection of the back, the dissector of the head and neck has merely to examine the superficial parts on the back of the neck, and take part along with the dissector of the upper limb in the dissection of those structures which are common to both.

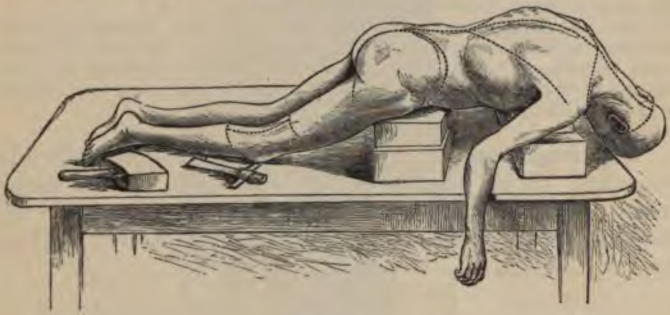

FIG. 62.

The *first day* should be devoted to the reflection of the skin, and the dissection of the superficial nerves and that portion of the posterior triangle of the neck which can be examined in the present position of the subject. On the *second day* the trapezius may be reflected, and the following structures examined—viz., the levator anguli scapulæ and its nerves, the posterior scapular artery, the superficial cervical artery, the suprascapular artery and nerve, the transversalis colli artery, and the origin of the omo-hyoid.

Surface Anatomy.—First make out the position of the external occipital protuberance, and having traced the superior curved line of the occipital bone as it passes outwards towards the mastoid process, press deeply into the neck immediately below the occiput, and in the middle line; here the bifid extremity of the massive spinous process of the axis vertebra can be felt. In the middle line of the neck is the *nuchal furrow.* Carrying the finger downwards in this, the posterior edge of the ligamentum nuchæ can be distinguished, but the short spines of the third, fourth, and fifth cervical vertebræ as a rule can hardly be detected. The spines of the sixth and seventh cervical vertebræ, however, are usually very prominent.

Reflection of Skin (Fig. 62).—Three incisions are required—(1) Along the middle line, from the external occipital protuberance to the prominent spine of the seventh cervical vertebra. (2) From the lower end of this mesial incision transversely outwards to the inner border of the acromion process of the scapula. (3) From the upper end of the primary incision transversely outwards over the occiput to the ear.

The quadrilateral flap of skin thus marked out must be raised from the subjacent superficial fascia. On reaching the side of the neck, the head must be held well over to the opposite side. Here, unless the dissector keep close to the skin, there is a danger of the knife slipping in under the posterior border of the sterno-mastoid muscle.

Superficial Nerves.—The nerves to be looked for in the superficial fascia, which is now exposed, are derived partly from the posterior primary divisions, and partly from the anterior primary divisions of the cervical nerves. They are:—

From posterior primary divisions.	1. Great occipital. 2. Terminal twigs of the internal branches of the third, fourth, and fifth nerves.
From anterior primary divisions.	1. Small occipital, 2. Great auricular.

Dissection.—The main trunk of the great occipital nerve may be found piercing the trapezius muscle about an inch below the occipital protuberance, and about half an inch external to the mesial plane. The fascia at this spot is usually very dense, and the readiest method to adopt in exposing the nerve is to carefully shave it off in slices until the plane of the muscle is reached.

The *great occipital* (nervus occipitalis magnus)—Fig. 63—is the internal branch of the posterior primary division of the second cervical nerve, and its branches of distribution have already been noticed, spreading out on the back of the scalp (p. 110). As it becomes superficial, it joins the occipital artery, and both are directed upwards to supply the scalp.

The terminal twigs of the *internal branches of the posterior divisions of the third, fourth, and fifth cervical nerves* enter the superficial fascia close to the mesial plane, and then turn transversely outwards to supply the skin of the neck.

The *third cervical branch* sends in addition a large twig upwards to the integument over the occiput. This nerve runs along the inner side of the great occipital, and, as a rule, communicates with it. From its distribution, it is frequently termed the *third occipital nerve* (nervus occipitalis tertius).

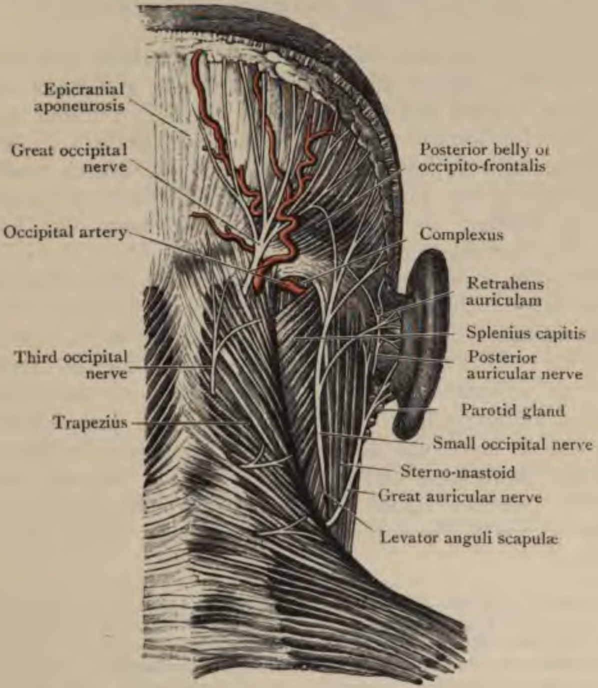
Epicranial aponeurosis
Great occipital nerve
Occipital artery
Third occipital nerve
Trapezius
Posterior belly of occipito-frontalis
Complexus
Retrahens auriculam
Splenius capitis
Posterior auricular nerve
Parotid gland
Small occipital nerve
Sterno-mastoid
Great auricular nerve
Levator anguli scapulæ

FIG. 63.—Superficial dissection of the Back of the Neck.

Dissection.—The small occipital nerve will be found by dividing the fascia along the posterior border of the sterno-mastoid muscle.

The *small occipital nerve* (nervus occipitalis minor)—Fig. 63—springs from the anterior primary division of the second cervical nerve, and runs upwards to assist in the supply of the integument over the occiput. Its terminal twigs have already been dissected in the superficial fascia of the scalp (p. 110).

Occasionally the small occipital is represented by two separate nerves.

Dissection.—The great auricular nerve can readily be exposed by drawing the head well over to the opposite side and then dividing the fascia over the outer surface of the sterno-mastoid muscle very obliquely. Begin the incision at the posterior margin of the muscle about the middle of the neck, and carry it upwards and forwards towards the lobule of the ear.

The *great auricular nerve* (nervus auricularis magnus)—Fig. 63—is a branch of the cervical plexus, and takes origin from the second and third cervical nerves. Turning round the posterior border of the sterno-mastoid muscle, it proceeds upwards and forwards on the surface of that muscle towards the lobule of the ear. Near this point it will be found to end by dividing into three sets of branches—viz., facial, auricular, and mastoid.

The *facial branches* will be traced afterwards in the dissection of the face. The others may be followed, however, at the present stage. The *auricular branches* supply the integument upon the cranial aspect of the auricle; and if they be carefully dissected, several of them will be noticed to pierce the cartilage to reach the integument on its outer surface. Communications may also be made out between these twigs and the posterior auricular branch of the facial nerve. The *mastoid branch* extends upwards upon the mastoid process, where it is connected with the posterior auricular and small occipital nerves.

Dissection.—Whilst the subject is lying upon its face we can only obtain a very meagre idea of the posterior triangle of the neck. It is only its upper and least important part which can at present be exposed. To bring the boundaries, floor, and contents of this portion into view, the dissector should begin by cleaning the cervical part of the trapezius. Occupying the interval between the trapezius and sterno-mastoid, two contiguous muscles, taking a somewhat oblique course, will be observed. The higher of these is the splenius capitis, and the lower is the levator anguli scapulæ. These, together with the posterior border of the sterno-mastoid, must be cleaned. In carrying out this dissection the dissector must proceed with some degree of caution; and above all, he must be careful not to raise the sterno-mastoid nor disturb the cervical nerves which lie under cover of it, because these can be studied at much greater advantage when the subject is turned. In cleaning the levator anguli scapulæ the dissector must secure two small nerves which issue from the cervical plexus for the supply of that muscle. They are closely applied to its surface, and are apt to be removed with the fascia covering the muscle, unless they are specially looked for. Further, the spinal accessory nerve, and two or three cervical nerves crossing from the posterior border of the sterno-mastoid to the trapezius, should be dissected out.

Posterior Triangle.—The upper part of the posterior triangle which is thus displayed is bounded *in front* by the posterior border of the sterno-mastoid, and *behind* by the anterior border of the trapezius. The *apex*, which is directed upwards, is formed at the superior curved line of the occipital bone by the apposition of the occipital attachments of these two muscles. The *floor* of that portion of the space which is exposed will be observed to be formed by the splenius capitis and the levator anguli scapulæ. But it often happens that the occipital attachments of the sterno-mastoid and trapezius (more especially of the latter) are so poorly developed that they fail to meet on the superior curved line of the occipital bone. In this case a small portion of the complexus (readily recognised by the vertical direction of its fibres) will be noticed entering into the formation of the floor of the space above the level of the splenius. The *contents* of the space, in so far as they can be seen in the present position of the body, are—(1) the great auricular and small occipital nerves as they appear at the posterior margin of the sterno-mastoid muscle; (2) the spinal accessory nerve, the cervical nerves to the trapezius, and two small nerves from the cervical plexus to the levator anguli scapulæ. An additional structure also enters the space when the sterno-mastoid and trapezius do not meet to form a distinct apex for the triangle, viz., the occipital artery. In such a case a small portion of the vessel will be noticed upon the complexus muscle, close to the superior curved line of the occipital bone.

Spinal Accessory Nerve (nervus accessorius).—This important nerve appears in the posterior triangle by emerging from the substance of the sterno-mastoid muscle. It crosses the triangle obliquely, running from above downwards and backwards, and finally disappears under the anterior border of the trapezius.

Cervical Branches to the Trapezius.—These are two or three nerves which spring from the third and fourth cervical trunks. They enter the posterior triangle by leaving the shelter of the sterno-mastoid, and are carried downwards and backwards across the space parallel with, but at a lower level than, the spinal accessory nerve. This, together with the fact that they are somewhat smaller than the spinal accessory, is sufficient to distinguish them from that nerve. They finally disappear under the anterior border of the trapezius.

Dissection.—On the second day after the subject has been placed on its face, the trapezius may be reflected. This must be done in conjunction with the dissector of the arm. First separate the muscle from the occipital bone, and then divide it about half an inch from the spines of the vertebræ. The muscle can now be raised and thrown outwards towards its insertion. On its deep surface the spinal accessory nerve, the cervical nerves of supply, and the superficial cervical artery will be noticed. It is the duty of the dissector of the upper limb to dissect these, but the dissector of the head and neck should trace the superficial cervical artery to its origin from the transversalis colli.

The attachments of the levator anguli scapulæ must also be defined. Two nerve twigs from the cervical plexus, which lie on its surface and finally enter its substance, have already been secured. Further, passing downwards under cover of this muscle, the *nerve to the rhomboids* and the *posterior scapular artery* will be found. Almost invariably the *nerve to the rhomboids* gives one or two twigs to the levator anguli scapulæ.

Levator Anguli Scapulæ (levator scapulæ).—This muscle arises by four slips from the posterior tubercles of the transverse processes of the upper four cervical vertebræ. These unite to form an elongated muscle which extends downwards and backwards to be inserted into that portion of the vertebral border of the scapula which is placed above the root of the spine. As already noted, the nerve-supply of the levator anguli scapulæ comes from the third and fourth cervical nerves, and also from the nerve to the rhomboids.

Transversalis Colli Artery.—This vessel will be seen terminating near the outer margin of the levator anguli scapulæ, by dividing into the *superficial cervical* and *posterior scapular arteries.* The former of these proceeds upon the superficial aspect of the levator anguli scapulæ, whilst the latter passes under cover of that muscle. It is the duty of the dissector of the upper limb to trace the further course of these branches of the transversalis colli artery.

Dissection.—The posterior belly of the omo-hyoid muscle, and the suprascapular artery and nerve, can now be displayed by dissecting towards the upper margin of the scapula. This dissection must be carried out in conjunction with the dissector of the upper limb, and it is well not to expose these structures at the present stage for more than an inch from the upper border of the scapula.

Posterior Belly of the Omo-hyoid.—This is a slender muscular band which arises from the upper border of the scapula, immediately behind the suprascapular notch. It also derives fibres from the ligament which bridges across this notch. The further connexions of the omo-hyoid will be studied in the dissection of the triangles of the neck after the body has been turned.

Suprascapular Artery and Nerve.—The *suprascapular artery* will be noticed to enter the supraspinous fossa of the scapula, by passing over the suprascapular ligament. The *suprascapular nerve*, on the other hand, is carried into the fossa under cover of the ligament.

The *second day's* work is now completed, and on the *same day* the dissector of the upper limb must finish his share of the dissection of the back, so as to allow the dissector of the head and neck to begin the examination of the deeper structures on the dorsal aspect of the trunk.

Two days are allowed for this dissection, and these may be disposed of in the following manner :—On the *first day*, all the muscles, fasciæ, nerves, and blood vessels of the back, with the exception of those in connection with the sub-occipital triangle, should be studied ; on the *second day*, the sub-occipital space must be examined, and the spinal cord displayed. Should the dissector find that the work is greater than he can undertake in the allotted time, the sub-occipital space may be left over until the head and neck is removed from the trunk.

Serrati Muscles.—These are two thin sheets of fleshy fibres, which are placed upon the posterior aspect of the thoracic wall. The *serratus posticus superior* (serratus posterior superior) is much the smaller of the two ; it arises by a thin aponeurotic tendon—(1) from the lower part of the ligamentum nuchæ ; (2) from the spinous process of the seventh cervical vertebra ; and (3) from the spinous processes of the upper two or three dorsal vertebræ. From this origin it proceeds obliquely downwards and outwards, and is inserted by distinct digitations into the outer surfaces of four ribs—viz., the second, third, fourth, and fifth—a short distance in front of their angles.

The *serratus posticus inferior* (serratus posterior inferior) will be brought into view by raising and throwing inwards that portion of the latissimus dorsi which the dissector of the upper limb has left attached to the lumbar fascia. The serratus posticus inferior will then be observed to take origin from the spinous processes of the last two dorsal and upper two lumbar vertebræ, as well as from the supraspinous ligaments which stretch between these bony prominences. The dissector will note, however, that this is not an independent and distinct attachment, but that it is effected through the medium of the vertebral aponeurosis and posterior lamella of the lumbar fascia, with both of which the aponeurotic tendon of the muscle blends. The serratus posticus inferior is directed upwards and outwards, and is inserted by four digitations into the lower borders of the four lower ribs.

Vertebral Aponeurosis.—The connections of the *vertebral aponeurosis* can be easily made out. It is the strong but thin and transparent fascia which bridges across the hollow between the spinous processes of the dorsal vertebræ and the portions of the ribs which lie internal to their angles. It confines in this hollow the proper muscles of the spine and head. Make a transverse incision through it about the middle of the dorsal region, and introduce under it the handle of a knife. By carrying this first in an inward and then in an outward direction, the attachment of the aponeurosis to the spines of the dorsal vertebræ and to the angles of the ribs will be rendered manifest. In the next place, note that when it is followed in an upward and downward direction the fascia presents a different relation to the two serrati muscles. Superiorly, it proceeds *under cover of* the serratus posticus superior and the splenius muscles, and is lost in the deep layers of fascia of the neck; inferiorly, *it blends* with the aponeurotic tendons of the serratus posticus inferior and the latissimus dorsi, and with these forms the posterior lamella of the lumbar fascia.

Lumbar Fascia.—The lumbar fascia is an exceedingly dense aponeurotic structure, which gives great support to the muscles of the loins, and also serves as a means of origin for two of the flat muscles of the abdominal wall—viz., the transversalis abdominis and obliquus internus. It is attached internally to the vertebral column by three distinct lamellæ, which are separated from each other by intervening muscular masses. The *posterior* or *superficial lamella* is at present seen in the form of a strong opaque aponeurotic sheet stretching outwards from the lumbar spines. It is formed, as we have already observed, by a continuation downwards of the vertebral aponeurosis, and by a union of this with the aponeurotic tendons of the latissimus dorsi and the serratus posticus inferior. Divide this lamella in a longitudinal direction about one inch external to the middle line, and raise it from the subjacent erector spinæ muscle.

Mesially it will be seen to have a strong attachment to the tips of the lumbar spines and the intervening supraspinous ligaments, whilst inferiorly it is fixed to the back part of the crest of the ilium, and to the subjacent tendon of the erector spinæ, where this lies upon the dorsum of the sacrum.

The erector spinæ should now be pushed inwards either with the fingers or with the handle of a knife. This proceeding will bring into view the *second* or *middle lamella* of the lumbar fascia. Further, the union of the posterior and middle lamellæ beyond the outer border of the erector spinæ, and the attachment of the middle lamella to the tips of the transverse processes of the lumbar vertebræ, may be seen. Note, however, that whilst the main attachment of this lamella is to the apices of the transverse processes, it also extends inwards between them and is attached to their contiguous margins. The next step consists in dividing the middle lamella longitudinally close to its vertebral attachment. The quadratus lumborum is then brought into view, and gently raising the middle lamella from the surface of this muscle until its outer border is exposed, the whole muscle should be pushed inwards. This brings into view the *third* or *anterior lamella* of the lumbar fascia, and its junction on the one hand with the middle lamella, and on the other with the bodies of the lumbar vertebræ close to the roots of the transverse processes, can be made out.

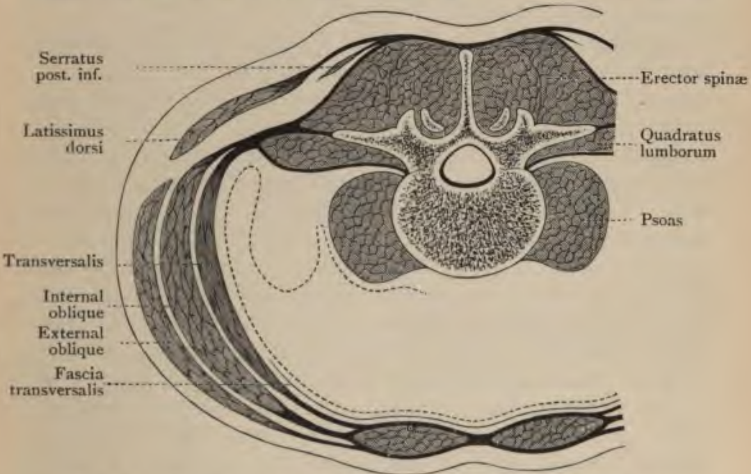
Serratus post. inf.
Latissimus dorsi
Transversalis
Internal oblique
External oblique
Fascia transversalis
Erector spinæ
Quadratus lumborum
Psoas

FIG. 64.—Diagram to show the Connections of the Lumbar Fascia.

The *lumbar fascia*, therefore, is formed at the outer borders of the erector spinæ and quadratus lumborum muscles by the union of these three lamellæ. Superiorly, it is attached to the last rib; inferiorly, it is fixed to the crest of the ilium; whilst externally it is continued into the transversalis abdominis muscle, of which it may be considered to be the posterior aponeurosis. By its superficial surface it gives origin to fibres of the internal oblique muscle of the abdominal wall.

Dissection.—The serratus posticus superior must be divided close to its origin from the vertebral spines, and turned outwards in order that the splenius muscle may be displayed.

Splenius Muscle.—The splenius has a continuous origin from rather more than the lower half of the ligamentum nuchæ, and from the spines of the seventh cervical and upper six dorsal vertebræ. From this the fibres pass obliquely upwards and outwards in the form of a thick, flat muscle, which soon divides into a cervical and a cranial portion. These are termed respectively the splenius colli and the splenius capitis.

The *splenius colli* (splenius cervicis) turns forwards and is inserted, behind the levator anguli scapulæ, by tendinous slips, into the posterior tubercles of the transverse processes of the upper two or three cervical vertebræ.

The *splenius capitis* passes under cover of the upper part of the sterno-mastoid muscle, and gains insertion into the lower part of the mastoid process and into the outer portion of the superior curved line of the occipital bone. To obtain a view of this insertion, the sterno-mastoid muscle may be divided along the superior curved line of the occipital bone as far as the mastoid process. Upon no account, however, detach it from the mastoid process.

Dissection.—The erector spinæ and complexus muscles must now be dissected. Begin by reflecting the splenius muscle. Detach it from its origin and throw it outwards and upwards towards its insertion. In doing this, preserve the cutaneous branches of the cervical nerves which pierce it.

When the splenius capitis is fully reflected, a small triangular space will be noticed close to the superior curved line of the occipital bone. In front, it is bounded by the trachelo-mastoid muscle; behind, by the outer border of the complexus; and above, by the superior curved line of the occipital bone. The floor of this little space is formed by the superior oblique muscle of the head, and it is traversed by the occipital artery, which in this part of its course gives off its arteria princeps cervicis branch.

Next remove the vertebral aponeurosis and turn the latissimus dorsi, the serratus posticus inferior, and the superficial lamella of the lumbar fascia outwards.

Erector Spinæ (sacro-spinalis).—Under this name we include a series of muscular strands which stretch with a greater or less degree of continuity along the entire length of the dorsal aspect of the spinal column. In the lumbar region it constitutes a bulky fleshy mass which may be considered the starting-point. This bulky mass sends a pointed process downwards on the back of the sacrum, and has the following origin:—(1) from the spines of the lower two dorsal, all the lumbar, and all the sacral vertebræ; (2) from the supraspinous ligaments which bind the lumbar and dorsal spines together; (3) from the back of the sacrum and from the posterior sacro-iliac ligament; (4) from the posterior fifth of the iliac crest. In great part the superficial surface of this muscular mass is covered by a very dense tendon, which in its lower part becomes blended, as already noted, with the superficial lamella of the lumbar fascia.

As the erector spinæ is followed upwards it is seen to divide into three columns. The outer column first separates from the general mass, and to it the name of *ilio-costalis* is given; the middle column is termed the *longissimus dorsi*; and the inner column, which only becomes quite distinct as we approach the upper part of the dorsal region, is called the *spinalis dorsi*.

Ilio-costalis (ilio-costalis lumborum).—The intermuscular interval between this muscle and the longissimus becomes apparent about the level of the last rib. The separation is rendered all the more distinct by the external branches of the posterior primary divisions of the dorsal spinal nerves which appear in the interval.

Turn the muscle outwards with the handle of the knife, and clean its slips of insertion. The nerves must at the same time be carefully preserved.

The *ilio-costalis* will now be observed to end in six or seven tendinous slips, which are inserted into the angles of the six or seven lower ribs. But wherever the ilio-costalis drops one of these slips, another tendinous slip takes origin from the upper border of the same rib. In this way a second muscle is formed, which continues the outer column of the erector spinæ upwards. This muscle is called the *musculus accessorius*.

Musculus Accessorius (ilio-costalis dorsi).—The musculus accessorius, therefore, arises close to the inner side of the ilio-costalis by six tendinous slips from the upper borders of the six lower ribs. It terminates in tendons which are inserted into the angles of the upper six ribs, and also into the transverse process of the lowest cervical vertebra.

Cervicalis Ascendens (ilio-costalis cervicis).—This muscle may be looked upon as the continuation of the outer column upwards into the neck. It arises close to the inner side of the accessorius by four slips from the third, fourth, fifth, and sixth ribs, and is inserted into the posterior tubercles of the transverse processes of the fourth, fifth, and sixth cervical vertebræ.

Longissimus Dorsi.—The longissimus dorsi is the largest of the three divisions into which the erector spinæ splits, and it extends upwards as high as the first dorsal vertebra. It is inserted by two distinct rows of tendinous and fleshy slips. The *inner row* consists of a series of tendons attached in the dorsal region to the tips of the transverse processes of all the dorsal vertebræ, and in the loin to the accessory processes of the lumbar vertebræ; the *outer row* is composed of fleshy slips, which are inserted in the dorsal region into the lower ten ribs, midway between their tubercles and angles, and in the loin to the transverse processes of the lumbar vertebræ and to the middle layer of the lumbar fascia. But this muscular column does not end in the dorsal region; it is carried up into the neck, and even reaches as high as the mastoid process of the skull by two muscular continuations termed respectively—(1) the transversalis cervicis, and (2) the trachelo-mastoid.

Transversalis Cervicis (longissimus cervicis).—The transversalis cervicis muscle takes origin in the upper dorsal region, by four or five slips from the transverse processes of a corresponding number of the upper dorsal vertebræ, and it gains insertion into the posterior tubercles of the transverse processes of all the cervical vertebræ, with the exception of the first and the last.

Trachelo-mastoid (longissimus capitis).—The trachelo-mastoid is prolonged upwards in the neck under cover of the splenius. Its origin from the transverse processes of three or four of the upper dorsal vertebræ is intimately associated with that of the transversalis cervicis. In addition to its dorsal origin, however, it also draws three or four slips from the articular processes of a like number of the lower cervical vertebræ. The narrow fleshy band which results is inserted into the back part of the mastoid process, under cover of the splenius capitis and sterno-mastoid muscles.

Spinalis Dorsi.—This, the innermost, shortest, and weakest of the three columns, is in some respects the most difficult to define. Below, it is intimately blended with the longissimus dorsi, but it may be regarded as taking origin by four tendons from the spines of the two upper lumbar and two lower dorsal vertebræ. These, by their union, form a small muscle, which is inserted by a series of slips into a very variable number of the upper dorsal spines. It is closely connected with the subjacent semispinalis dorsi.

Dissection.—The occipital artery has already been observed crossing the apex of the posterior triangle (p. 137), and its terminal branches have been dissected as they ramify in the scalp (p. 112). The second part of the vessel, which extends from under shelter of the mastoid process, along the superior curved line of the occipital bone, to the point where it pierces the trapezius to become superficial, can now be fully exposed. To effect this, the trachelo-mastoid must be divided a short distance below its insertion, and along with the splenius capitis thrown upwards as far as possible.

Occipital Artery (arteria occipitalis).—The second part of the occipital artery is now displayed. In the region of the mastoid process it is very deeply placed; indeed, no less than five structures lie superficial to it. These are (enumerating them in order from the vessel outwards)—(1) the origin of the posterior belly of the digastric muscle; (2) the mastoid process; (3) the trachelo-mastoid; (4) the splenius capitis; and (5) the sterno-mastoid.[1] As the artery runs backwards, it very soon emerges from under cover of the first three of these structures, and a little farther on it leaves the shelter of the splenius; so that it is covered by the sterno-mastoid alone. Issuing from under cover of the posterior border of this muscle, the artery crosses the apex of the posterior triangle, and disappears under the trapezius, which it finally pierces near the external occipital protuberance, to reach the scalp. Two muscles constitute its deep relations—viz., the insertion of the superior oblique and the complexus.

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[1] It is not uncommon to find the artery at this point of its course nearer the surface. It may pass backwards between the splenius and the trachelo-mastoid.

The following *branches* may be traced from this portion of the occipital artery :—

1. Arteria princeps cervicis.
2. Mastoid.
3. Muscular.

The *arteria princeps cervicis* (ramus descendens) is a twig of some size, which passes inwards to the outer border of the complexus. Here it divides into a superficial and a deep branch. The former ramifies on the surface of the complexus, whilst the latter pursues a deeper course. It sinks under cover of that muscle, and will be followed to its destination at a later stage in the dissection.

The small *mastoid artery* (ramus mastoideus) enters the posterior cranial fossa through the mastoid foramen, and supplies the dura mater and cranial wall in this region.

The *muscular twigs* go to the neighbouring muscles.

The *veins* corresponding to the occipital artery are two, or perhaps three, in number. They drain the blood from the occipital portion of the scalp, and open into the vertebral and deep cervical veins. The outermost of the occipital veins effects, as a general rule, a communication (emissarium mastoideum) with the lateral sinus through the mastoid foramen.

Dissection.—In cleaning the complexus muscle, and in defining its attachments, care must be taken of the internal branches of the posterior primary divisions of the second, third, fourth, and fifth cervical nerves. The first of these—or, in other words, the great occipital—from its great size, runs little risk of injury, but the others are liable to be overlooked. They all emerge from the substance of the muscle close to the mesial plane.

Complexus.—The complexus muscle, placed in the cervical and upper dorsal regions, inclines obliquely upwards and inwards to its insertion into the occiput. It arises by tendinous slips from the transverse processes of the upper six dorsal vertebræ, and by three slips from the articular processes of the fourth, fifth, and sixth cervical vertebræ. A thick fleshy muscle is thus formed, and this is inserted into a large, somewhat oval impression between the superior and inferior curved lines of the occipital bone, close to its crest. The muscle narrows somewhat as it passes upwards, and is separated from its neighbour of the opposite side by the ligamentum nuchæ.

The inner portion of the muscle, which is to a certain extent distinct from the general mass, and is divided into two bellies by an intermediate tendon, is frequently designated the *biventer cervicis.*

Dissection.—The complexus must now be reflected by detaching it from the occiput and throwing it outwards. This dissection requires care, not only on account of the nerves which have been seen to perforate it to reach the surface, but also on account of the structures which it covers. In its upper part it lies over the sub-occipital triangle and the muscles bounding it, whilst below it covers the semispinalis muscle. A thick dense fascia is placed over these subjacent parts, and in this we find certain of the cervical nerves and the anastomosis between the arteria princeps cervicis and arteria profunda cervicis. The dissector must specially look for a small twig from the sub-occipital nerve which enters the deep surface of the upper part of the complexus, and for a larger branch to the same muscle from the great occipital nerve. The inner margin of the complexus will be seen to be in contact with a mesial fibrous partition which separates it from the corresponding muscle of the opposite side. This is the ligamentum nuchæ.

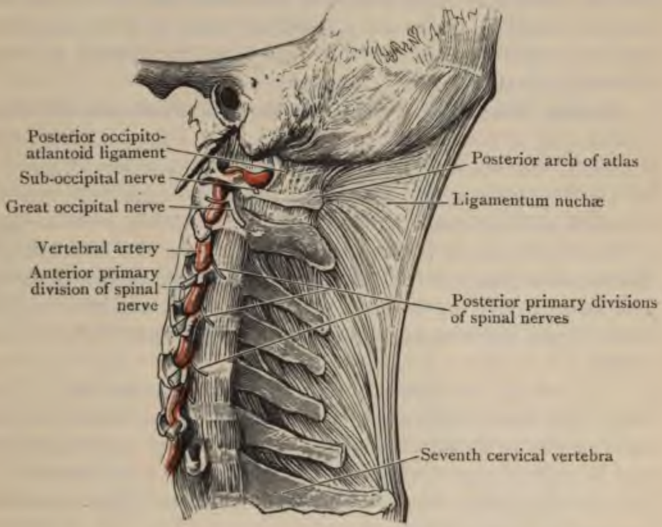
Posterior occipito-atlantoid ligament
Sub-occipital nerve
Great occipital nerve
Vertebral artery
Anterior primary division of spinal nerve
Posterior arch of atlas
Ligamentum nuchæ
Posterior primary divisions of spinal nerves
Seventh cervical vertebra

FIG. 65.—Dissection of the Ligamentum Nuchæ and of the Vertebral Artery in the Neck.

Ligamentum Nuchæ (Fig. 65).—This is a strong fibrous partition placed in the mesial plane between the muscles on each side of the back of the neck. It represents a powerful elastic structure in quadrupeds, which helps to sustain the weight of the dependent head. In man, however, there is not much elastic tissue developed in connexion with it, and it appears to be a continuation upwards of the supraspinous ligament from the spine of the seventh cervical vertebra to the external occipital protuberance. In shape it is somewhat triangular. By its base it is attached to the crest of the occipital bone; by its anterior border it is fixed by a series of slips to the posterior tubercle of the atlas, and to the bifid spines of the cervical vertebræ in the intervals between their tubercles. Its apex is formed by its attachment to the spine of the seventh cervical vertebra, whilst its posterior border is, in a measure, free, and gives origin to the trapezius, rhomboid, serratus posticus superior, and splenius muscles.

Arteria Princeps Cervicis and Arteria Profunda Cervicis.—The *deep cervical artery* springs from the superior intercostal branch of the subclavian, and reaches the dorsum by passing backwards between the transverse process of the last cervical vertebra and the neck of the first rib. At the present stage of the dissection it is seen ascending upon the semispinalis colli muscle and anastomosing with the *arteria princeps cervicis.* The latter artery, as we have seen, is a branch of the occipital. Both vessels likewise anastomose with twigs from the vertebral artery.

The arteria profunda cervicis is accompanied by a large vein—the *vena profunda cervicis.* This vessel begins in the sub-occipital region, where it is joined by the occipital veins, and it ends in the vertebral vein close to its termination. It reaches this point by turning forwards under the transverse process of the last cervical vertebra.

Posterior Primary Divisions of the Spinal Nerves.—The nerves of the back must now be examined. They are the posterior primary divisions of the spinal nerves. With *four* exceptions (viz., the first cervical, fourth and fifth sacral, and the coccygeal nerves), each posterior division will be found to divide into an *external* and an *internal branch.*

Examine these nerves successively in the cervical, dorsal, and lumbar regions. It is well, however, to defer the dissection of the sacral and coccygeal nerves until the multifidus spinæ muscle has been studied.

Cervical Region.—Here the posterior primary divisions of the spinal nerves are eight in number. The posterior division of the *first* or *sub-occipital nerve*, which, as we have seen, fails to divide into an external and an internal branch, lies deeply in the sub-occipital triangle, and will be examined when this space is dissected.

The posterior primary division of the *second cervical nerve* is very large, and appears between the neural arches of the atlas and axis vertebræ. The posterior primary divisions of the succeeding *six cervical nerves* arise from the corresponding spinal nerve-trunks in the intervertebral foramina a short distance farther out, and, turning backwards under cover of the posterior intertransverse muscles, appear in the intervals between the transverse processes.

The *external branches* are of small size, and are entirely devoted to the supply of muscles. They give twigs to the splenius colli and to the cervical and cranial prolongations of the erector spinæ.

The *internal branches* are not all distributed alike, nor indeed do they present the same relations. Those from the *second*, *third*, *fourth*, and *fifth nerves* run inwards towards the spinous processes, superficial to the semispinalis colli muscle, and under cover of the complexus. When close to the mesial plane they turn backwards, pierce the complexus, splenius, and trapezius muscles, and become superficial. In their course to the surface they give numerous twigs to the neighbouring muscles.

The internal branch of the second nerve is remarkable for its large size. It receives the special name of *great occipital.* It will be noticed turning round the lower border of the inferior oblique muscle, to which it supplies some twigs. In passing to the surface it pierces the complexus and trapezius. To the former it gives several twigs. The distribution of this nerve on the occiput has already been noticed (p. 110).

The internal branch of the third nerve likewise sends an offset to the occipital portion of the scalp (p. 135).

The internal branches of the *lower three* posterior divisions of the cervical nerves resemble the preceding, in so far that they take a course inwards towards the spinous processes. They differ from them, however, in running under cover of the semispinalis muscle, and in being, as a rule, entirely expended in the supply of muscles.

Dorsal Region.—The posterior primary divisions of the dorsal nerves make their appearance in the intervals between the transverse processes. The *external branches* proceed outwards under cover of the middle column of the erector spinæ muscle, and appear in the interval between the longissimus dorsi on the one hand, and the ilio-costalis and accessorius on the other. The *upper six or seven* of these nerves are exhausted in the supply of the middle and outer columns of the erector spinæ, and the levatores costarum; the *lower five or six*, however, are considerably larger, and contain both motor and sensory fibres. After giving up their motor fibres to the same muscles, they become superficial, by piercing the serratus posticus inferior, and the latissimus dorsi, in a line with the angles of the ribs. The cutaneous distribution of these nerves has already been examined by the dissector of the upper limb.

The *internal branches* are also distributed differently in the upper and lower portions of the dorsal region. The *lower five or six* are very small, and end in the multifidus spinæ muscle. The *upper six or seven* pass inwards between the multifidus and semispinalis, and after supplying the muscles between which they are situated, they are directed backwards, and become superficial. In passing towards the surface they pierce the splenius, rhomboideus, and trapezius muscles, and thus gain the superficial fascia, where they have been already dissected.

Lumbar Region.—The *internal branches* of the posterior divisions of the five lumbar nerves are of small size, and, like the corresponding twigs in the lower dorsal region, they have a purely muscular distribution. They end in the multifidus spinæ muscle.

The *external branches* sink into the substance of the erector spinæ, and are concerned in the supply of that muscle, and also of the lumbar intertransverse muscles. The *upper three* of these nerves are of large size, and become cutaneous by piercing the superficial lamella of the lumbar fascia. They have already been traced by the dissector of the lower limb to the skin of the gluteal region. The lowest external branch communicates with the corresponding branch of the first sacral nerve.

Blood Vessels of the Back.—In the *cervical region* the dissector has already noticed the arteria profunda cervicis, the second part of the occipital artery, and its branch termed the arteria princeps cervicis. Deep in the sub-occipital region he will subsequently meet with a small portion of the vertebral artery. In addition to these, however, minute twigs may be discovered, in a well-injected subject, passing backwards from the vertebral artery in the intervals between the transverse processes, and also in the sub-occipital space. These supply the muscles, and anastomose with the other arteries in this region.

In the *dorsal region* the *dorsal branches* of the aortic intercostal arteries make their appearance between the transverse processes. Each of these vessels reaches this point by passing backwards in the interval between the body of a vertebra and the superior costo-transverse ligament. It is associated with the corresponding posterior primary division of a spinal nerve, and with it is distributed to the muscles and integument of the back.

In the *lumbar region* similar branches are derived from the lumbar arteries. They are distributed in the same manner.

In both dorsal and lumbar regions these vessels, before reaching the back, furnish small *spinal branches* which enter the spinal canal through the intervertebral foramina. These will be traced at a later period.

The accompanying *veins* of the dorsal branches of the lumbar and intercostal arteries pour their blood into the lumbar and intercostal veins. These veins are of large size, being joined by tributaries from the dorsal spinal venous plexus, and also by others from the interior of the spinal canal.

Transversus Spinalis.—Under this name are included a system of muscles which occupy the vertebral groove from the back of the sacrum as high as the axis vertebra. When this muscular mass is analysed, it is found to consist of three strata, each of which is composed of a series of bundles or slips pursuing a more or less oblique course. As the term given to the whole system implies, these slips for the most part stretch from the transverse processes upwards and inwards to be inserted into the spinous processes of the vertebræ. The superficial slips pass over five or more vertebræ and connect distant points on the column; the deeper slips are shorter, and the most deeply placed of all merely pass between contiguous vertebræ.

The superficial layer is termed the *semispinalis muscle*; the intermediate layer is called the *multifidus spinæ*; whilst the deep stratum is composed of a series of short muscles, termed the *rotatores spinæ*. In the dorsal and cervical regions we find the three layers; in the lumbar and sacral regions the semispinalis is absent.

Dissection.—The semispinalis muscle is already in great part exposed. To display it fully, however, it is necessary to remove the spinalis dorsi muscle.

Semispinalis Muscle.—This muscle may be described in two parts—the semispinalis dorsi and semispinalis colli.

The *semispinalis dorsi* is composed of a series of muscular slips, with long tendons at either end, which arise from the transverse processes of five of the lower dorsal vertebræ (viz., from the sixth to the tenth). It is inserted into the spines of the upper four dorsal and lower two cervical vertebræ.

The *semispinalis colli* lies under cover of the complexus. It springs from the transverse processes of the upper five dorsal vertebræ, and is inserted into the spines of four cervical vertebræ (viz., from the second to the fifth).

The slips composing the semispinalis muscle stretch over five or more vertebræ.

Dissection.—The multifidus spinæ is of great extent. Beginning in the sacral region, it passes upwards as far as the axis vertebra. It is weakly developed in the dorsal region, but is strongly marked in the loin and in the neck—more especially in the former. To bring it thoroughly into view, the semispinalis muscle must be detached from the spines and thrown outwards: the erector spinæ muscle must also be separated from the lumbar and sacral spines and drawn aside—if, indeed, this has not been already done in following out the nerves.

Multifidus Spinæ (multifidus).—In the *lumbar* and *sacral regions* the multifidus will be seen to constitute a thick fleshy mass, which clings closely to the vertebral spines. In this situation it has a very extensive origin—viz., (1) from the deep surface of the aponeurotic origin of the erector spinæ; (2) from the posterior surface of the sacrum as low as the fourth aperture; (3) from the posterior sacro-iliac ligament; (4) from the posterior superior spine of the ilium; and (5) from the mammillary processes of the lumbar vertebræ. In the *dorsal region* it takes origin from the transverse processes of the vertebræ, and in the *cervical region* from the articular processes of at least four of the lower cervical vertebræ. The bundles which compose the multifidus pass over two, three, or four vertebræ, and are inserted into the whole length of the various spinous processes of the movable vertebræ as high up as the axis.

Rotatores Spinæ (submultifidus).—These are a series of small muscles which may be exposed by raising the multifidus. In the dorsal region each muscle springs from the root of a transverse process, and is inserted into the lamina of the vertebra immediately above, close to the root of the spinous process. Somewhat similar muscles have been described in the cervical and lumbar regions, and also a series of longer and more superficial slips which connect alternate vertebræ with each other (Hughes).

Interspinales and Intertransversales.—The dissector should next examine the minute interspinous and intertransverse muscles.

The *interspinous muscles* can hardly be said to exist in the dorsal region, except in its upper and lower parts, where they are present in a rudimentary condition. In the neck they are arranged in pairs—two occupying each interspinous interval, with the exception of that between the axis and atlas. In the lumbar region they are also well marked and in pairs; here they are attached to the whole length of the spinous processes.

The *intertransverse muscles* (intertransversarii) are strongly developed in the lumbar region, and occupy the entire length of the intertransverse intervals. Additional rounded fasciculi may be observed passing between the accessory processes. These are termed the *interaccessorii.*

In the *dorsal region* intertransverse muscles—very weak and poorly developed—are only found in the lower three or four spaces.

In the *cervical region* the intertransversales are present in pairs. They will be better examined at a subsequent period.

Levatores Costarum.—These constitute a series of twelve fan-shaped muscles, which pass from the transverse processes to the ribs. To bring them thoroughly into view, the longissimus dorsi, ilio-costalis, and accessorius muscles should be removed. The first muscle of the series springs from the tip of the transverse process of the last cervical vertebra, and, expanding as it proceeds downwards and outwards, is inserted into the outer border of the first rib, immediately beyond the tubercle. Each of the succeeding muscles takes origin from the tip of a dorsal transverse process, and is inserted into the outer surface of the rib immediately below, along a line extending from the tubercle to the angle.

Posterior Primary Divisions of the Sacral Nerves.—These are very small. The *upper four* will be found emerging from the posterior sacral foramina; the *fifth* appears at the lower end of the sacral canal.

To expose the *upper three* the multifidus spinæ muscle covering the upper three sacral apertures must be carefully removed. Each of these three nerves will be found to divide in the usual manner into an internal and external branch.

The *internal branches* are very fine, and end in the multifidus spinæ.

The *external branches* are somewhat larger, and join together so as to form a looped plexus upon the back of the sacrum. This communicates above with the external branch of the last lumbar nerve and below with the posterior division of the fourth sacral nerve. Branches proceed from the loops thus formed to the surface of the great sacro-sciatic ligament. Finally they become superficial by piercing the gluteus maximus muscle, and they supply a limited area of skin over the gluteal region. They have already been examined by the dissector of the lower limb.

The *lowest two* posterior primary divisions of the sacral nerves do not exhibit the usual division into external and internal branches. They are very small, and, after communicating with each other, and also with the *coccygeal nerve*, they distribute filaments to the parts on the back of the lower portion of the sacrum and on the dorsal aspect of the coccyx.

Minute twigs from the lateral sacral artery accompany the sacral nerves and anastomose with twigs from the gluteal and sciatic arteries.

Posterior Division of the Coccygeal Nerve.—This is a slender twig which emerges from the inferior opening of the sacral canal, and, after being joined by a filament from the last sacral nerve, is distributed on the back of the coccyx.

Dorsal Spinal Venous Plexus.—A plexus of veins is situated upon the superficial aspect of the neural arches of the vertebræ, subjacent to the multifidus muscle. This plexus collects blood from the integument and muscles of the back, and in the dorsal and lumbar regions pours it into the posterior tributaries of the intercostal and lumbar veins. In the neck it is especially well marked, and its blood is emptied into the vertebral veins. It is hardly to be expected, however, that the dissector, in an ordinary dissection, will make out much of these venous channels.

Directions.—The last day upon which the body is allowed to remain in its present position must be devoted to the dissection of the sub-occipital triangle, and to the display of the spinal cord, its membranes, nerve-roots, and blood-vessels.

In the event of the dissector being pushed for time, it is better that he should proceed at once to expose the spinal cord, and defer the dissection of the sub-occipital region until the head and neck has been removed from the body.

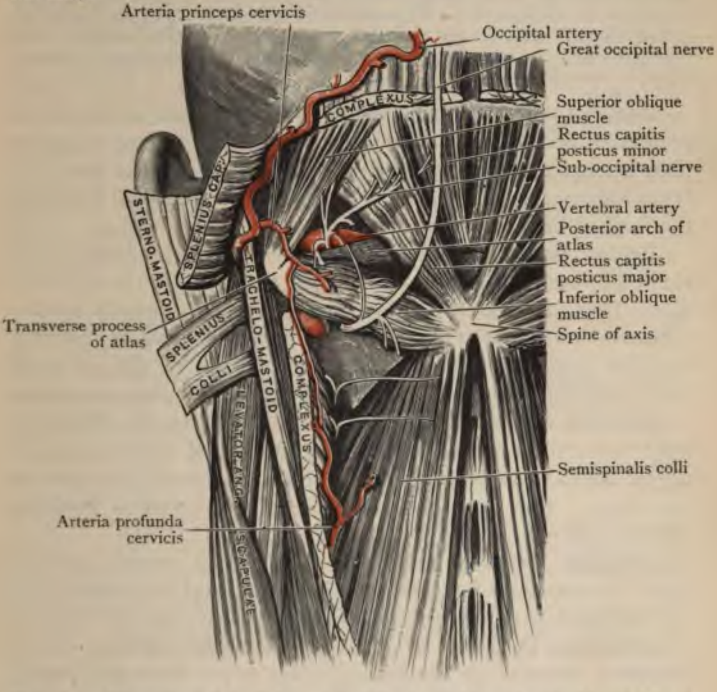
Arteria princeps cervicis
Occipital artery
Great occipital nerve
COMPLEXUS
Superior oblique muscle
Rectus capitis posticus minor
Sub-occipital nerve
SPLENIUS CAP.
STERNO-MASTOID
Vertebral artery
Posterior arch of atlas
Rectus capitis posticus major
TRACHELO-MASTOID
Inferior oblique muscle
Transverse process of atlas
SPLENIUS COLLI
Spine of axis
COMPLEXUS
LEVATOR ANG. SCAPULAE
Semispinalis colli
Arteria profunda cervicis

FIG. 66.—Dissection of the Sub-occipital Region. Note that in this specimen the occipital artery is superficial to the trachelo-mastoid muscle.

Sub-Occipital Space.—The sub-occipital space is a small triangular area, exposed by the reflection of the complexus muscle. It is *bounded* by three muscles—viz., (1) the rectus capitis posticus major, which forms its upper and inner boundary; (2) the obliquus inferior, which limits it below; and (3) the obliquus superior, which bounds it above and to the outer side. When dissected, *its floor* will be found to consist of two structures—viz., the posterior arch of the atlas and the thin posterior occipito-atlantal ligament. It *contains* within its area a portion of the vertebral artery and the posterior primary division of the sub-occipital or first cervical nerve.

Dissection.—Before cleaning the muscles bounding the triangle, the sub-occipital nerve must be secured. This can best be done by tracing into the space the minute twig which it has been seen to give to the deep surface of the complexus, or, if this has not been observed, by endeavouring to find the twig which it gives to the rectus capitis posticus major. The tissue in which the nerve lies is very dense, and the dissection in consequence is rendered somewhat difficult.

Rectus Capitis Posticus Major.—This muscle springs by a pointed origin from the spine of the axis, and, expanding as it passes upwards and outwards, it is inserted into the occipital bone along the outer portion of the inferior curved line and the surface immediately below.

Rectus Capitis Posticus Minor.—This is a minute fan-shaped muscle, placed to the inner side and upon a deeper plane than the preceding muscle. It takes origin from the tubercle on the posterior arch of the atlas, and is inserted into the inner part of the inferior curved line of the occipital bone and the surface between this and the foramen magnum.

Obliquus Capitis Inferior.—This muscle stretches from the bifid spine of the axis, from the extremity of which it takes origin, to the posterior tubercle of the transverse process of the atlas. The great occipital nerve will be seen hooking round its lower border.

Obliquus Capitus Superior.—This small muscle springs from the transverse process of the atlas, and is inserted into the occipital bone in the interval between the curved lines.

Posterior Division of the Sub-Occipital Nerve.—The posterior division of the sub-occipital nerve does not divide into an external and internal branch. It enters the sub-occipital triangle by passing backwards between the posterior arch of the atlas and the vertebral artery; so that even in cases where all its branches have been divided, the trunk is readily found in this position. The nerve at once breaks up into branches which go to supply five muscles—viz., the two recti, the two oblique muscles, and the complexus. In addition to these muscular twigs it gives a *communicating*, and sometimes a *cutaneous filament.*

The *communicating branch* generally proceeds from the nerve to the obliquus capitis inferior, and joins the great occipital nerve. The *cutaneous branch* when present accompanies the occipital artery to the integument over the occiput.

Vertebral Artery (arteria vertebralis).—It is only a small portion of this vessel which occupies the sub-occipital triangle. Emerging from the foramen in the transverse process of the atlas, it runs backwards and inwards in the groove upon the posterior arch of the same bone. In this course it crosses the sub-occipital nerve, and lies immediately behind the lateral mass of the atlas. It leaves the space and enters the cranial cavity through the foramen magnum by turning forwards below the posterior occipito-atlantal ligament and piercing the dura mater.

Small branches proceed from the vertebral artery in this situation to supply the parts in its immediate neighbourhood, and to anastomose with the arteria princeps cervicis and the arteria profunda cervicis.

Dissection to open the Spinal Canal.—The first step consists in thoroughly cleaning the vertebral laminæ and spinous processes upon either side. The multifidus spinæ must also be completely removed from the back of the sacrum. At the same time the posterior primary divisions must be retained, so that their continuity with the various spinal nerve-trunks may be afterwards established. The posterior wall of the spinal canal should now be removed *in one piece* by sawing through the laminæ of the vertebræ on either side, and dividing the ligamenta subflava, from the third cervical vertebra down to the lower opening of the canal on the back of the sacrum.

In making this dissection the student must attend to the following points:—(1) the cut should be directed through the laminæ close to the inner side of the articular processes; (2) the saw must be used in an oblique plane, so that the cut through the laminæ slants slightly inwards; (3) in cutting through the cervical laminæ the head and neck should hang over the end of the table, and be pressed as far forwards as possible whilst the saw is worked from below upwards; (4) in the case of the lumbar region, where, indeed, most difficulty will be met, a high block must be placed under the abdomen of the subject, whilst the blocks supporting the chest and pelvis are removed. It will probably be necessary at this point to have recourse to the hammer and chisel.

The laminæ and spinous processes which are thus removed are connected with each other by the ligamenta subflava and the supraspinous and interspinous ligaments. They should therefore be laid aside for the present. A description of these ligaments will be found farther on. When the specimen is fresh, however, the dissector should note the high elasticity of the ligamenta subflava. This can be tested by stretching the specimen.

Between the dura mater and the walls of the spinal canal, the dissector will notice a quantity of loose areolar tissue and soft fat. The latter is especially plentiful in the sacral region, where it resembles somewhat the marrow which occupies the medullary cavity of a long bone. In the midst of this areolo-fatty material, great numbers of large veins and minute arteries are found ramifying upon the walls of the canal.

Spinal Arteries.—A minute spinal artery in a well-injected subject will be seen entering the spinal canal through each intervertebral foramen. These arteries are derived from different sources in the different regions of the spine. In the cervical region they come from the vertebral artery; in the dorsal region from the dorsal branches of the intercostal arteries; in the lumbar region from the dorsal branches of the lumbar arteries. They supply with blood the spinal cord and its meninges, the bones, the periosteum, and the ligaments; and their arrangement is very much the same in each of the three regions.

Each spinal artery may be looked upon as giving off *three main twigs*: of these, one, termed the *pre-laminar branch*, a very small twig, ramifies upon the deep surface of the neural arches and ligamenta subflava; another, the *neural branch*, can be followed to the dura mater, which it pierces immediately above the point of exit of the corresponding spinal nerve; whilst the third, the *post-central branch*, is carried inwards in front of the dura mater towards the posterior surface of the vertebral bodies. The last-mentioned branch divides into an ascending and descending twig. These anastomose with the corresponding twigs of the arteries above and below, and in this manner a continuous series of minute arterial arcades is formed. From these arcades, branches pass inwards so as to form a series of cross anastomoses with the corresponding vessels of the opposite side.

In the *cervical region* small branches from the ascending cervical artery also find their way into the spinal canal; whilst in the *sacral portion* of the canal the dissector will find branches from the lateral sacral arteries.

Intraspinal Veins.—These are very large and very complicated in their arrangement. They may be looked upon as forming a posterior and an anterior intraspinal plexus.

The *posterior intraspinal venous plexus* consists of two main longitudinal vessels, united by many cross branches, which run along the deep aspect of the neural arches and ligamenta subflava. Above, they communicate with the occipital sinus, whilst all the way down they are connected with the *dorsal spinal venous plexus* by wide channels which pierce the ligamenta subflava. Laterally they send branches through the intervertebral foramina to join the posterior branches of the intercostal and lumbar veins.

The *anterior intraspinal venous plexus* cannot be dissected whilst the spinal cord and its membranes are *in situ*, but it will be more convenient to describe it at this stage. Indeed, the dissection is one of considerable difficulty, even under the most advantageous circumstances. Like the preceding, it is composed of two longitudinal venous channels placed one upon either side of the posterior common ligament of the vertebral bodies, and joined by numerous transverse branches which cross the mesial plane under cover of this ligament. These transverse veins receive large tributaries from the interior of the vertebral bodies. Superiorly each of the main longitudinal channels communicates with the occipital and basilar sinuses within the cranium, and gives off a branch which emerges above the neural arch of the atlas to form the commencement of the vertebral vein. Opposite the various intervertebral discs they send off branches which run towards the intervertebral foramina, and, joining the corresponding branches of the posterior intraspinal plexus, form a plexus around the corresponding spinal nerve.

Meninges of the Spinal Cord—Fig. 67.—The spinal cord, like the brain, with which it is continuous, is enveloped by three membranes termed *meninges*. The most external investment is a strong fibrous membrane called the *dura mater*; the second, in order from without inwards, is a non-vascular tunic termed the *arachnoid mater*; whilst the third and most internal is the *pia mater*. These membranes are directly continuous with the corresponding investments of the brain.

Dissection.—The outer surface of the dura mater must now be cleaned. This is effected by removing from the spinal canal the loose areolar tissue, soft fat, and posterior intraspinal veins. It is necessary, also, to carefully define the numerous lateral prolongations which the membrane gives to the spinal nerves.

Dura Mater Spinalis—Fig. 67.—In the spinal canal the dura mater constitutes an exceedingly dense and tough fibrous tube, which extends from the foramen magnum above, to the level of the second or third piece of the sacrum below. Even before this tube of membrane is laid open, the dissector can readily satisfy himself that it is very loosely adapted to the spinal cord and the nerve-roots which form the cauda equina; in other words, it is very capacious in comparison with the volume of its contents. Its calibre, moreover, is by no means uniform; in the cervical and lumbar regions it is considerably wider than in the dorsal region, whilst in the sacral canal it rapidly contracts and finally ends by blending with the filum terminale, a fibrous thread which is prolonged downwards through the sacral canal from the extremity of the spinal cord. *Above*, the dura mater is firmly attached to the third cervical vertebra, to the axis vertebra, and around the margin of the occipital foramen; *below*, the filum terminale, on which it terminates, can be traced as far as the dorsal aspect of the coccyx, where it is lost by blending with the periosteum investing that bone.

If the student recall the characteristics of the cranial dura mater, he cannot fail to observe certain striking points of difference between it and the spinal dura mater. The relations which the latter presents to the walls of the spinal canal are altogether different. Within the cranial cavity the dura mater is closely adherent to the bones, and forms for them an internal periosteum. As it is traced into the spinal canal, however, it splits at the foramen magnum into its two constituent layers. The inner of these two laminæ is carried downwards as the long cylindrical tube which encloses the spinal cord. The outer lamina, which is very much thinner, becomes continuous, behind and on each side of the foramen magnum, with the periosteum on the exterior of the cranium, whilst in front it is prolonged downwards into the vertebral canal in connection with the ligaments and periosteum on the anterior wall of the canal. The spinal dura mater corresponds, therefore, to the supporting layer of the cranial dura mater and to it alone. It is separated from the walls of the spinal canal and its lining periosteum by an interval or space, which is filled by loose fat, areolar tissue, and the intraspinal plexuses of veins. In connexion with the spinal dura mater there are no venous sinuses such as are present in the cranial cavity, but it should be noted that the intraspinal veins, placed between the periosteum of the spinal canal and the tube of dura mater, occupy the same morphological plane as the cranial sinuses. Another feature which serves to distinguish the spinal dura mater from the cranial dura mater consists in the fact that it gives off from its deep surface no partitions or septa.

The cylindrical tube of spinal dura mater does not lie free within the vertebral canal, although its attachments are of such a nature that they do not in any way interfere with the free movement of the vertebral column. On either side the spinal nerve-roots, as they pierce the dura mater, carry with them into the intervertebral foramina tubular sheaths of the membrane, whilst in front loose fibrous prolongations—more numerous above and below than in the dorsal region—connect the tube of dura mater to the posterior common ligament of the vertebral column. No connexion of any kind exists between the dura mater and the neural arches of the vertebræ or ligamenta subflava.

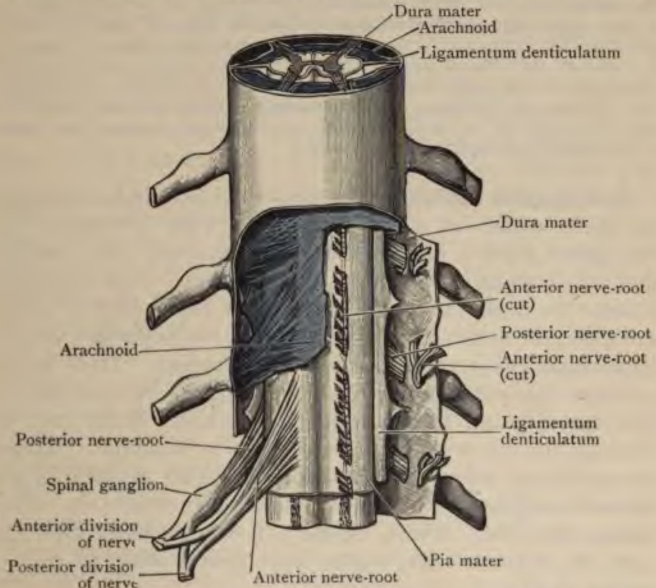
Dura mater
Arachnoid
Ligamentum denticulatum
Dura mater
Anterior nerve-root (cut)
Posterior nerve-root
Anterior nerve-root (cut)
Arachnoid
Ligamentum denticulatum
Posterior nerve-root
Spinal ganglion
Anterior division of nerv
Posterior divisio of nerve
Pia mater
Anterior nerve-root

FIG. 67.—Membranes of the Spinal Cord, and the mode of origin of the Spinal Nerves.

Dissection.—The tube of dura mater may now be opened with the scissors. The incision should be carried through the membrane in the mesial plane. Care, however, must be taken not to injure the delicate arachnoid, which is subjacent.

Subdural Space (cavum subdurale).—The capillary interval between the dura mater and the arachnoid mater is termed the *subdural space*—Fig. 67. The deep surface of the dura, which is turned towards this space, is smooth, moist, and polished. Upon either side the dissector will notice the series of apertures of exit for the roots of the spinal nerves. These are ranged in pairs opposite each intervertebral foramen. The subdural space is prolonged outwards for a short distance upon each of the nerve-roots, and has a free communication with the lymph paths present in these nerves.

Viewed from the inside of the tube of dura mater, each of the two nerve-roots belonging to a spinal nerve is seen to carry with it a special and distinct sheath. When examined, however, on the outside of the tube of dura mater, the appearance is such that the dissector might be led to conclude that both roots are enveloped in one sheath. This is due to the fact that the two sheaths are closely held together on the outside by intervening connective tissue, which can be removed with a little careful dissection. When this is done, the two tubular sheaths will be observed to remain distinct as far as the ganglion on the posterior root of the nerve. At this point they blend with each other.

Arachnoidea Spinalis—Fig. 67.—The arachnoid resembles the dura mater in forming a loose, wide investment for the spinal cord. Unlike the dura, however, it is remarkable for its great delicacy and transparency. The sac which it forms is most capacious towards its lower part, where it envelops the extremity of the cord and the collection of long nerve-roots which constitute the *cauda equina.* Here it can be most easily demonstrated by making an incision into it, and inserting the handle of the scalpel, or, better still, by inflating the sac with air by means of a blowpipe. Above, the arachnoid mater becomes continuous at the level ot the foramen magnum with the corresponding membrane which clothes the brain, whilst, laterally, it is prolonged outwards upon the various nerve-roots, thus contributing to each a tubular sheath.

Sub-arachnoid Space (cavum subarachnoideale)—Fig. 67.—This term is applied to the wide space between the arachnoid and pia mater. It is occupied by a variable amount of cerebro-spinal fluid, and is directly continuous with the cranial sub-arachnoid space. Three incomplete septa partially subdivide the spinal sub-arachnoid space into compartments. One of these septa is a mesial partition called the *septum posticum*, which connects the pia mater covering the posterior aspect of the cord with the arachnoid mater. In the upper part of the cervical region the septum posticum is very imperfect, and is simply represented by a number of strands passing between the two membranes; in the lower part of the cervical region and in the dorsal region it becomes tolerably complete. The other two septa are formed by the ligamenta denticulata. These spread outwards from each side of the spinal cord, and will be studied with the pia mater.

Dissection.—Clear away the arachnoid mater from a portion of the cord, and proceed to the study of the pia mater.

Pia Mater Spinalis.—This is a firm vascular membrane, which closely invests and is firmly adherent to the surface of the spinal cord. It is thicker and denser than the corresponding membrane which envelops the brain. This is largely due to the addition of an outer fibrous layer in which the fibres chiefly run in the longitudinal direction. The pia mater is firmly attached to the surface of the spinal cord, and in front it sends a fold into the antero-median fissure of the cord. The septum which occupies the postero-median fissure of the cord is likewise firmly attached to its deep surface. Anteriorly, in the mesial plane, the pia mater is thickened in the form of a longitudinal glistening band, which receives the name of the *linea splendens*. Of course, this can only be seen after the cord has been removed from the spinal canal. The blood vessels of the cord lie between the two layers of the pia mater, and the various spinal nerves receive from it closely fitting sheaths which blend with their connective-tissue sheaths.

Ligamentum Denticulatum—Figs. 67 and 68.—This is a remarkable band, which stretches outwards from either side of the pia mater, so as to connect it with the dura mater. Its *pial* or *inner attachment* extends in a continuous line between the anterior and posterior nerve-roots, from the level of foramen magnum above to the level of the body of the first lumbar vertebra below. Its *outer margin* is widely serrated or denticulated. From twenty to twenty-two denticulations may be recognised. They occur in the intervals between the spinal nerves, and, pushing the arachnoid before them, they are attached by their pointed extremities to the inner surface of the dura mater.

The ligamenta denticulata partially subdivide the subarachnoid space into an anterior and a posterior compartment. In the anterior compartment the anterior nerve-roots pass outwards; the posterior compartment contains the posterior nerve-roots, and is imperfectly subdivided into two lateral subdivisions by the septum posticum.

By means of the ligamentum denticulatum of either side, the spinal cord is suspended in the middle of the sac of dura mater.

Spinal Cord (medulla spinalis).—The spinal cord itself may now be studied *in situ*. It is a cylindrical structure, slightly flattened in front and behind, which extends from the margin of the foramen magnum, where it is continuous with the medulla oblongata of the brain, to the lower border of the body of the first or the upper border of the body of the second lumbar vertebra. Its lower end rapidly tapers to a point, and is termed the *conus medullaris*. From the extremity of this, a slender filament, termed the *filum terminale* or *central ligament*, is prolonged downwards.

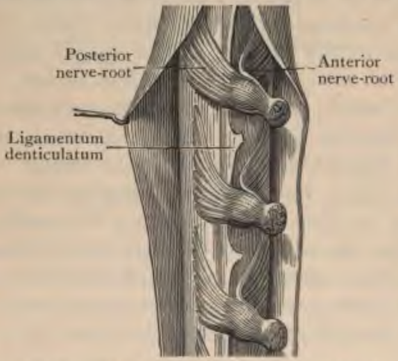

FIG. 68.—Lateral view of the Spinal Cord, Dura Mater, and Ligamentum Denticulatum. (Hirschfeld and Leveillé.)

In the female the average length of the spinal cord is 43 cm.; in the male it is 45 cm.

Throughout the greater part of the dorsal region the spinal cord presents a uniform girth, but in the cervical and lower dorsal regions it shows marked swellings, termed respectively the *cervical* and *lumbar enlargements*. From these expansions proceed the nerves which supply the upper and lower limbs. The *cervical swelling* (intumescentia cervicalis) is the more evident of the two. It begins at the upper end of the cord and attains its greatest breadth (13 to 14 mm.) opposite the fifth or sixth cervical vertebra. Below, it subsides opposite the second dorsal vertebra. The *lumbar swelling* (intumescentia lumbalis) begins at the level of the tenth dorsal vertebra, and attains its maximum transverse diameter (11 to 13 mm.) opposite the last dorsal vertebra. Below, it rapidly tapers into the tapering conus medullaris.

Filum Terminale.—This delicate thread-like filament lies amidst the numerous long nerve-roots which occupy the lower part of the spinal canal, and it can readily be detected from these (1) by its silvery glistening appearance, and (2) by its continuity with the extremity of the *conus medullaris.*

Although the central canal of the spinal cord is prolonged down in its interior for nearly half its length, and nervous elements can be traced in its substance for a like distance, the filum terminale is chiefly composed of pia mater carried downwards from the conus medullaris. The *linea splendens* and the lower ends of the *ligamenta denticulata* may also be considered to be continued into it. At the level of the second or third sacral vertebra it pierces the tapered end of the tube of dura mater, and receives an investment from it, and, finally, reaching the lower end of the sacral canal, it terminates by blending with the periosteum on the back of the coccyx or last piece of the sacrum.

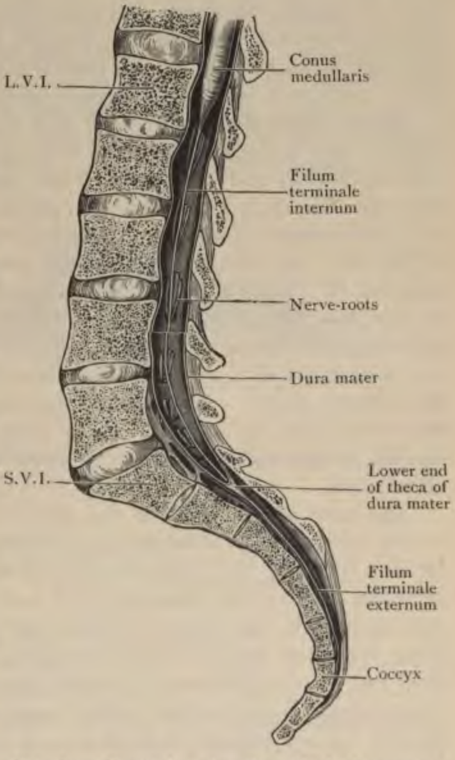

FIG. 69.—Sagittal section through the lower part of the Vertebral Canal.

In length the filum terminale measures about six inches. The part within the tube of dura mater is termed the *filum terminale internum*, the portion outside is distinguished as the *filum terminale externum.*

Spinal Nerves.—Thirty-one spinal nerves take origin from each side of the spinal cord. These are classified into five groups, according to the vertebræ with which they are associated. The dorsal, lumbar, and sacral nerves correspond in number with the number of vertebræ in each of these regions, —thus, there are twelve dorsal, five lumbar, and five sacral nerves, each of which issues from the spinal canal below the vertebra with which it numerically corresponds. In the cervical region, however, there are eight nerves, the first of which comes out between the occiput and the atlas, and is therefore distinguished by the special name of the *sub-occipital nerve.* There is only one coccygeal nerve on each side.

Spinal Nerve-Roots—Figs. 67 and 70.—Each spinal nerve springs from the side of the spinal cord by *two roots*—an *anterior* (radix anterior) and a *posterior* (radix posterior). Except in the case of the sub-occipital nerve (where, indeed, the posterior root is sometimes absent), the posterior nerve-root is the larger of the two. In addition to this, the posterior root is distinguished by possessing an oval ganglion, termed the *spinal root-ganglion* (ganglion spinale). There is, likewise, a wide physiological difference between the two roots,—the posterior root is composed of afferent fibres, the anterior root consists of efferent fibres. Immediately beyond the ganglion the two roots unite to form the *spinal nerve-trunk*, which, in consequence, contains a mixture of both efferent and afferent nerve-fibres.

The *mode of attachment* of the two nerve-roots to the side of the spinal cord is somewhat different in the two cases. In each instance they are attached by several separate fasciculi (fila radicularia), which spread out from each other as they approach the cord. In the case of the posterior root these enter the cord consecutively along a continuous straight line and at the bottom of a slight furrow. The fasciculi of the anterior root, on the other hand, are not so regularly placed. They emerge from the cord over an area of some breadth. The portion of the spinal cord which stands in connection with a pair of nerves receives the name of a "segment of the cord."

The *size* of the nerve-roots will be observed to differ greatly. The lower lumbar and upper sacral nerve-roots are much the largest, whilst the lower sacral and the coccygeal roots are the smallest. In the cervical region the roots increase in size from above downwards, but more rapidly in the lower members of the group; in the dorsal region the roots of the first nerve are large, but those which succeed it are small and of uniform size.

In *relative length*, and in the *direction* which they follow in the spinal canal, the nerve-roots also show great differences. This is due to the spinal cord being so much shorter than the canal in which it lies. In the upper part of the cervical region the nerve-roots are short, and proceed outwards in a more or less horizontal direction. Below this the nerve-roots gradually lengthen, and have to descend in the spinal canal for a distance which is always increasing the farther down we go. The arrangement of the lower dorsal, the lumbar, sacral, and coccygeal nerve-roots is particularly characteristic. They are exceedingly long, and descend vertically from the lower portion of the cord, in the form of a bunch or leash which, from its appearance, has been termed the *cauda equina*.

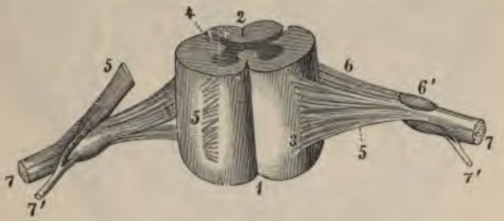

FIG. 70.—A segment of the spinal cord; anterior aspect. (Schwalbe, after Allen Thomson.)

1. Anterior median fissure.
2. Posterior median fissure.
3 and 5. Fasciculi of anterior nerve-root.
4. Postero-lateral groove.
6. Posterior nerve-root.
6′. Spinal ganglion.
7. Anterior primary division.
7′. Posterior primary division.

Mode of Exit of Spinal Nerves from Spinal Canal.—The six lower cervical nerves, the dorsal nerves, and the lumbar nerves make their exit through the intervertebral foramina; whilst the two divisions of each of the upper four sacral nerves find their way out by the sacral foramina. The two upper cervical nerves, the fifth sacral nerve, and the coccygeal nerve, however, follow a different course. The sub-occipital emerges by passing over the neural arch of the atlas, and the second cervical nerve by passing over the neural arch of the axis. The fifth sacral and the coccygeal nerve leave the sacral canal through its lower aperture (Fig. 71).

Dissection.—The nerve-roots of one or two spinal nerves in each region should be followed into the corresponding intervertebral foramina. This can be easily done by snipping away the articular processes with the bone-pliers. The position of the ganglion on the posterior root, the connections of the sheath of dura mater, the union of the two roots to form the spinal nerve-trunk, and the division of the latter into the anterior and posterior primary divisions, can thus be studied. An attempt should also be made at the same time to discover the minute *ramus meningeus.* This is a fine twig which is formed by the union of a small filament from the spinal nerve-trunk with a minute branch from the sympathetic cord. It takes a recurrent course through the intervertebral foramen to end in the bones and periosteum of the vertebral canal.

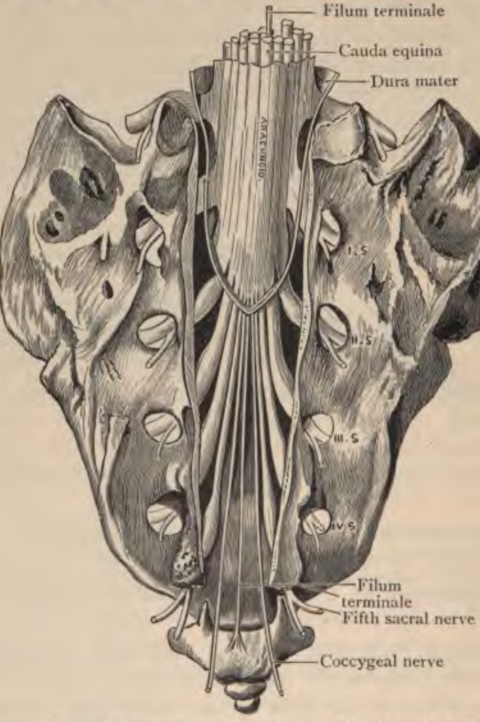

FIG. 71.—Sacral Canal opened up from behind to show the Sacral Nerve-roots (lower part of Cauda Equina) and the Membranes in relation to them. (After Testut.)

Spinal Root-Ganglia.—These ganglia are oval swellings developed upon the posterior nerve-roots, just before they unite with the anterior roots to form the spinal nerve-trunks.

They are usually found upon the posterior roots of all the nerves, although occasionally the ganglion may be absent in the case of the sub-occipital nerve.

Except in the case of the two upper cervical nerves, and the sacral and coccygeal nerves, the spinal ganglia are formed upon the posterior nerve-roots as they lie in the intervertebral foramina. The ganglia of the first two cervical nerves lie upon the neural arches of the first and second cervical vertebræ respectively; the ganglia of the sacral nerves are placed within the sacral canal, but outside the tube of dura mater. The ganglion on the posterior root of the coccygeal nerve will be found inside the tube of dura mater.

Spinal Nerve-Trunks.—These are formed by the union of the anterior and posterior nerve-roots immediately beyond the spinal ganglia, and from what has been said it must be evident that this union takes place in the case of the coccygeal and sacral nerves in the sacral canal; in the lumbar, dorsal, and lower six cervical nerves, in the intervertebral foramina; and in the case of the first two cervical nerves, on the neural arches of the atlas and axis.

The nerve-trunk is exceedingly short; indeed, it almost immediately divides into its *anterior* and *posterior primary divisions.* In the case of the sacral and coccygeal nerves, this subdivision takes place in the sacral canal, and the spinal nerve-trunks of these nerves are distinctly longer than in the case of the nerves which occupy a higher level.

The distribution of the posterior primary divisions has already been examined (p. 148).

Dissection.—At this stage the dissector may adopt one of two methods in the further treatment of the cord and the nerves which spring from it. If the cord is fresh and in such a condition that it may be successfully hardened, it is best to transfer it at once to the preservative fluid. If, on the other hand, it is soft and not fit for proper preservation, it should be removed with all its membranes and nerve-roots, and placed in a cork-lined tray filled with water. There is no method by which the arachnoid, the pia mater, the ligamenta denticulata, and the nerve-roots can be so well studied as this.

In removing the spinal cord, the spinal nerves should be divided as they lie in the intervertebral foramina, and in such a manner that as long a piece as possible of each nerve remains attached to the dura mater and the cord. Wherever it is possible the ganglia should be taken with the nerves. The same rule also applies to the sacral nerves. The cord and its membranes should then be cut across at the highest limit of the vertebral dissection. By pulling upon the dura mater the whole specimen may now be lifted from the vertebral canal and transferred to the water-bath. The dura mater should then be slit down the mesial plane over the front of the cord, and the edges of each lateral piece drawn outwards. By fixing the dura mater to the cork at the bottom of the tray with pins, the further dissection can be conducted with great advantage.

Arteries of the Spinal Cord.—It is only in cases where a paint or a starch injection has been used that the spinal arteries can be made out satisfactorily.

A large number of small arteries are supplied to the spinal cord. These are the *anterior* and *posterior spinal arteries* which spring from the vertebral, and a series of *lateral spinal* or *neural arteries* which reach the side of the spinal cord and are derived from different sources in each region. *In the neck* they come from the spinal branches of the vertebral, ascending cervical, and deep cervical arteries; and *in the dorsal* and *lumbar regions* from the spinal twigs of the dorsal branches of the intercostal and lumbar arteries. By the anastomoses of these arterial twigs, five longitudinal trunks are formed upon the surface of the spinal cord. One of these occupies the mesial plane in front, and may be termed the *antero-median artery*. The other four are placed in relation to the sulci along which the posterior nerve-roots enter the cord. One runs downwards in front of the line of entrance of these roots, and the other behind it on each side of the cord. These slender arterial trunks may therefore be termed the *postero-lateral longitudinal vessels*.

The *antero-median vessel* is formed in its upper part by the union of the two anterior spinal branches of the vertebral arteries. One of these is larger than the other, and takes a much greater share in the formation of the median trunk. Below the level of the fifth pair of cervical nerves the continuity of the median vessel depends upon the reinforcements which it obtains from the lateral spinal vessels. The number of lateral spinal arteries which join the median vessel is very variable. The majority of these arteries end on the nerve-roots; five to ten only reach the median vessel. The *antero-median artery* runs downwards, under cover of the linea splendens of the pia mater. Its calibre is uniform throughout, and where the cord ends it proceeds onwards for some distance upon the filum terminale.

The *postero-lateral arteries* on each side of the cord are formed in the upper part of the cervical region by the bifurcation of the corresponding posterior spinal branch of the vertebral artery. Lower down their continuity is maintained by twigs which reach them on the posterior roots of the spinal nerves from the lateral spinal arteries. It may be regarded as a rule, that where a lateral spinal artery gives a branch to one of the postero-lateral arterial trunks, it does not furnish another to the antero-median arterial trunk. In this way different lateral spinal arteries are in connexion with the longitudinal trunks on the anterior and posterior aspects of the cord. The postero-lateral vessels end at the lower extremity of the cord.

From the five main arterial channels which thus extend along the cord numerous anastomosing twigs ramify in the pia mater.

Veins of the Spinal Cord.—These veins are small and numerous, and their disposition cannot be said to correspond with that of the arteries. They are very tortuous, and form a plexus with elongated meshes. Six more or less perfect longitudinal venous trunks may be noticed on the surface of the cord in connection with this plexus. Two of these are mesial, and are placed respectively on the anterior and posterior aspects of the cord. The anterior trunk runs upwards under cover of the antero-median spinal artery. The other four are lateral, and are situated two on either side of the cord in relation respectively to the anterior and posterior nerve-roots.

Upon either side, the veins of the spinal cord effect communications with the veins in the spinal canal by means of small twigs which run outwards on the nerve-roots.

How to distinguish the anterior from the posterior surface of the spinal cord.

ANTERIOR SURFACE.	POSTERIOR SURFACE.
1. Linea splendens.	1. The postero-lateral arteries in relation to the posterior nerve-roots.
2. Single anterior spinal artery in mesial plane.	2. Fasciculi of origin of posterior nerve-roots entering the cord along a straight and continuous line, and at the bottom of a distinct sulcus.
3. Anterior nerve-roots smaller than posterior, and springing by fasciculi which emerge from the cord, not in a continuous straight line, but irregularly over an area of some width.	3. Posterior nerve-roots larger than the anterior, and provided with ganglia.

Preservation of the Spinal Cord.—If the spinal cord be in a fit state for preservation, the dissector should immerse it for a few weeks in methylated spirit, to which a small amount (4 per cent) of formalin has been added. When sufficiently firm, the dissector should endeavour to learn something of its internal structure by making transverse sections through it at different levels, and inspecting the cut surface closely with the naked eye, or with the aid of a magnifying glass.

Internal Structure of the Spinal Cord.—A good deal can be learned by a naked-eye inspection of cross sections of the cord made in different regions and at different levels.

The spinal cord is then seen to be a bilateral structure.

It is partially subdivided into a right and a left half by two median clefts,—one upon the anterior, and the other upon the posterior aspect. These clefts are called the *antero-median* and the *postero-median fissures*, and they extend along the entire length of the cord.

At the same time, it must be noted that these two median fissures present many points of difference. The antero-median fissure is, for the greater part of its length, much shallower than the postero-median fissure; further, it is wider and much more apparent, and the pia mater dips down into it to form a fold or reduplication within it. The postero-median cleft, in addition to its being deeper and narrower, contains only a single septum of neuroglia.

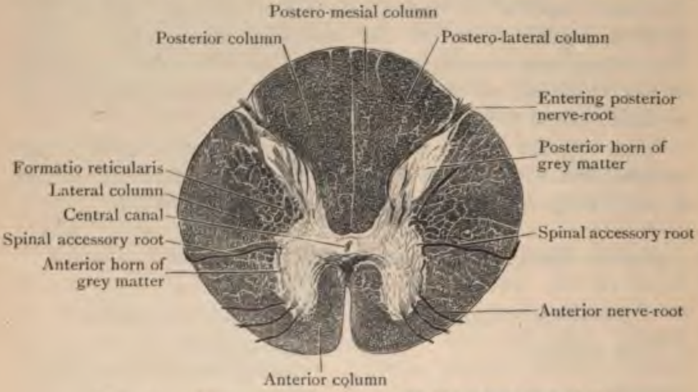
Postero-mesial column
Posterior column
Postero-lateral column
Entering posterior nerve-root
Posterior horn of grey matter
Formatio reticularis
Lateral column
Central canal
Spinal accessory root
Anterior horn of grey matter
Spinal accessory root
Anterior nerve-root
Anterior column

FIG. 72.—Transverse section through the upper part of the Cervical Region of the Cord.

The two halves of the cord thus marked off from each other are to all intents and purposes symmetrical, and they are joined by a more or less broad band or commissure which intervenes between the two median fissures.

An inspection of the surface of each lateral half of the cord brings into view a groove or furrow at some little distance from the postero-median furrow. Along the bottom of this groove the fasciculi of the posterior nerve-roots enter the cord in accurate linear order. It is called the *postero-lateral sulcus*. There is no corresponding furrow on the fore-part of each lateral half of the cord in connection with the emergence of the fasciculi of the anterior nerve-roots. As we have already observed, these fascicles emerge over a broad area, which corresponds in its width to the thickness of the subjacent extremity of the anterior horn of grey matter.

By means of the postero-lateral sulcus and line of entrance of the fascicles of the posterior nerve-roots on the one hand, and the emergence of the fascicles of the anterior nerve-roots on the other hand, the surface of each lateral half of the cord is subdivided into three columns, which are respectively termed posterior, lateral, and anterior. The *posterior column* (funiculus posterior) is placed between the postero-median fissure and the postero-lateral furrow; the *lateral column* (funiculus lateralis) lies between the postero-lateral furrow and the outermost of the fascicles of the anterior nerve-roots as they emerge from the cord; the *anterior column* (funiculus anterior) includes that district which extends from the antero-median fissure to the emergence of the outermost of the anterior nerve-root fascicles.

The spinal cord is composed of an inside core of grey matter which is surrounded on all sides by an external coating of white matter.

Grey Matter of the Spinal Cord.—The grey matter in the interior of the spinal cord has the form of a fluted column. When seen in transverse section, it presents the shape of the letter H. In each lateral half of the spinal cord there is a crescentic mass shaped somewhat like a comma, the concavity of which is directed outwards, and the convexity inwards. The two crescents of opposite sides are connected across the middle line by a transverse band, which is called the *grey commissure*. The postero-median fissure cuts through the cord until it reaches the grey commissure. The bottom of the antero-median fissure is separated from it by an intervening strip of white matter which is termed the *anterior white commissure* (commissura anterior alba). In the grey commissure may be seen the central canal of the cord (canalis centralis). It is just visible to the naked eye as a minute speck. This canal tunnels the entire length of the cord, and opens above (after having traversed the lower half of the medulla oblongata) into the fourth ventricle of the brain. The portion of the grey commissure which lies behind the central canal is called the *posterior grey commissure* (commissura posterior); the portion in front receives the name of *anterior grey commissure* (commissura grisea anterior).

In each crescentic mass of grey matter certain well-defined parts may be recognised. The projecting portions which extend behind and in front of the connecting transverse grey commissure are termed respectively the *posterior* and the *anterior cornua* of grey matter (columnæ griseæ). These can be distinguished from each other at a glance.

The *anterior cornu* is short, thick, and very blunt at its extremity. Further, its extremity falls short of the surface of the cord, and is separated from it by a tolerably thick coating of white matter. Through this the fascicles of the anterior nerve-roots pass on their way to the surface. The thickened end of the anterior cornu is termed the *caput cornu*, whilst the slightly constricted part close to the grey commissure is called the *cervix cornu*. The *posterior cornu* is in most localities in the cord elongated and narrow. Further, it is drawn out to a fine point which almost reaches the bottom of the postero-lateral sulcus. This pointed extremity receives the name of the *apex cornu*; the slightly swollen part which succeeds it is the *caput cornu*; whilst the slightly constricted part adjoining the grey commissure goes under the name of the *cervix cornu*.

Covering the tip of the posterior cornu there is a substance which differs in its composition from the general mass of grey matter, and presents a translucent appearance. It is termed the *substantia gelatinosa of Rolando*.

When we apply the terms cervical, dorsal, lumbar, sacral, etc., to different portions of the cord, we refer to those parts of the cord to which the different groups of nerves are attached.

The grey matter is not present in equal quantity throughout the entire length of the cord. It may be regarded as a general law that wherever there is an increase in the size of the nerves attached to a particular part of the cord, there a corresponding increase of the grey matter may be noticed. It follows from this that the districts in which the grey matter bulks most largely are the lumbar and cervical swellings. The great nerves which go to form the limb plexuses enter and pass out from those portions of the cord. In the intermediate dorsal region there is a reduction in the quantity of grey matter in correspondence with the smaller size of the dorsal nerves.

But the shape of the crescentic masses of grey matter is not the same in all regions. In the dorsal region both horns are narrow, although the distinction between the anterior horn and the more attenuated posterior horn is still sufficiently manifest. In the cervical region the contrast between the cornua is most marked; the anterior horn is very thick in comparison with the much narrower posterior horn. In the lumbar region, on the other hand, the difference in the thickness of the two horns is not nearly so apparent owing to a broadening out of the posterior horn. A section taken from the centre of each of these regions can very readily be recognised by these features.

In the dorsal region of the cord, more especially in the upper part, there is another character which is very distinctive. A pointed and prominent triangular projection juts out from the external aspect of the crescentic mass of grey matter nearly opposite the grey commissure. This is called

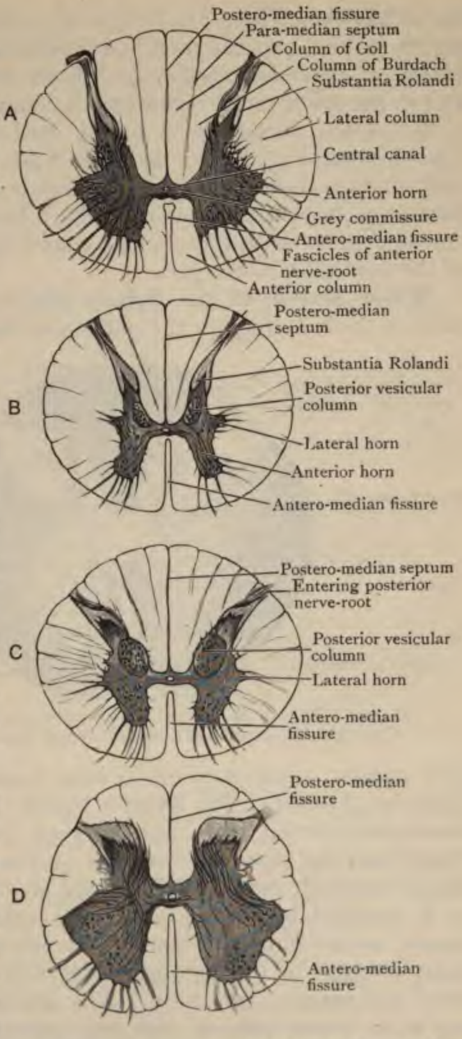
Postero-median fissure
Para-median septum
Column of Goll
Column of Burdach
Substantia Rolandi
A
Lateral column
Central canal
Anterior horn
Grey commissure
Antero-median fissure
Fascicles of anterior nerve-root
Anterior column
Postero-median septum
Substantia Rolandi
Posterior vesicular column
B
Lateral horn
Anterior horn
Antero-median fissure
Postero-median septum
Entering posterior nerve-root
Posterior vesicular column
C
Lateral horn
Antero-median fissure
Postero-median fissure
D
Antero-median fissure

FIG. 73.—Transverse sections through the Cord in different regions. A. Cervical Region; B. Mid-dorsal Region; C. Lower Dorsal Region; D. Lumbar Region.

the *lateral horn* (Fig. 73, B and C). It disappears in the region of the cervical and lumbar swellings, but, curiously enough, it again becomes evident both in the upper cervical and in the lower sacral regions of the cord.

Below the dorsal region of the cord the postero-median cleft becomes gradually shallower and the antero-median cleft deeper, until in the sacral region they are found to present a very nearly equal depth. The central canal, in correspondence with this change, comes to occupy the centre of the cord in its lower part.

White Matter of the Spinal Cord.—The white matter forms a thick coating on the outside of the fluted column of grey matter. It is marked off into three columns (funiculi medullæ spinalis). The *posterior column* is wedge-shaped in transverse section, and lies between the postero-median fissure and the posterior cornu of grey matter. The *lateral column* occupies the concavity of the grey crescent. Behind, it is bounded by the posterior grey cornu and the postero-lateral sulcus, whilst in front it extends as far as the outermost fasciculi of the anterior nerve-roots as they pass out from the anterior grey horn. The *anterior column* includes the white matter between the antero-median fissure and the anterior horn of grey matter, and also the white matter which separates the thick extremity of the anterior grey cornu from the surface of the cord. This latter portion of the anterior column is traversed by the emerging fascicles of the anterior nerve-roots.

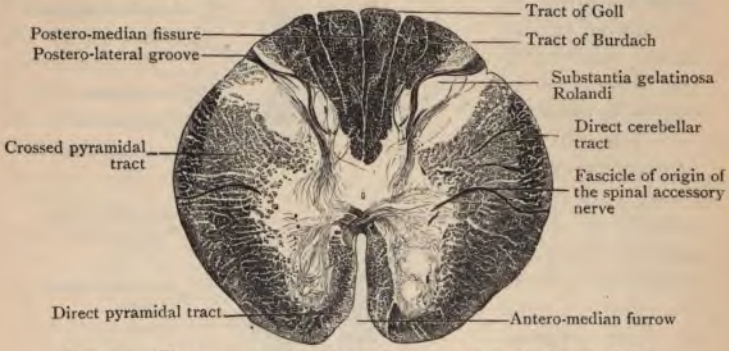
Tract of Goll
Postero-median fissure
Tract of Burdach
Postero-lateral groove
Substantia gelatinosa Rolandi
Direct cerebellar tract
Crossed pyramidal tract
Fascicle of origin of the spinal accessory nerve
Direct pyramidal tract
Antero-median furrow

FIG. 74.—Transverse section through the upper cervical part of the Cord of a full-time Fœtus treated by the Pal-Weigert process.

In the cervical region a faint longitudinal groove runs downwards on the surface of the posterior column of the cord. This indicates the position of a septum which passes into the column from the deep surface of the pia mater and divides it incompletely into two unequal strands. The groove is termed the *paramedian furrow*; the smaller and more internal of the two strands is called the *postero-median column* or *the tract of Goll*, whilst the outer and larger strand receives the name of the *postero-external column* or *the tract of Burdach*.

The white matter of the spinal cord increases steadily in quantity from below upwards.

The tracts of Goll and Burdach, which form the posterior column of the cord, are composed of fibres which enter the cord through the fascicles of the posterior nerve-roots. In the lower portion of the cord the septum of pia mater which intervenes between these two strands fails, so that it is only in the upper part of the cord that they are marked off from each other.

In the lateral and anterior columns of the adult cord it is not possible to distinguish the different strands of fibres; and yet we know that such exist, possessing different functions and presenting different connexions. In the fœtal cord, however, the medullary sheath is developed at a later period around the fibres of certain tracts than in the case of others; and if thin sections of developing cords be subjected to the Pal-Weigert staining process, the tracts in which the medullary sheaths have appeared are dyed black and stand out in marked contrast to the non-medullated tracts which remain pale (Fig. 74). In the present instance it is only necessary to indicate the three best-defined tracts in the antero-lateral part of the cord. These are (1) the ascending direct cerebellar tract; (2) the descending crossed pyramidal tract; (3) the descending direct pyramidal tract.

The *direct cerebellar tract* medullates comparatively early. Consequently in Fig. 74 it stands out conspicuously as a narrow area placed on the surface of the cord, in the posterior part of the lateral column, immediately in front of the postero-lateral groove. It ascends to the cerebellum, but, traced in the opposite direction, it is found to disappear in the lower dorsal area of the cord. The *crossed pyramidal tract*, when seen in transverse section, occupies a larger district of the cord. Further, it medullates late, and the area which it occupies appears pale in Fig. 74. It is placed in the lateral column in front of the posterior horn of grey matter and immediately internal to the direct cerebellar tract. As the direct cerebellar tract fails in the lower reaches of the cord the crossed pyramidal tract comes to the surface, and it can be traced as low as the fourth sacral nerve. The *direct pyramidal tract* forms the narrow strip of the anterior column which lies immediately adjacent to the antero-median furrow. Like the crossed pyramidal tract it medullates late, and therefore in Fig. 74 it appears pale. It only reaches down to about the middle of the dorsal region of the cord and then disappears.

SIDE OF THE NECK.

Four days having now been devoted to the dissection of the posterior aspect of the body, the subject is turned on its back, and blocks being placed under the thorax and pelvis, the dissection of the side of the neck is commenced. This region may be said to present a somewhat quadrilateral figure. *In front*, it is bounded by the middle line of the neck; *behind*, it is limited by a line corresponding to the anterior margin of the trapezius muscle; *below*, are the upper margin of the manubrium sterni and the prominent clavicle; *above*, the base of the lower jaw, the mastoid process, and the occiput.

Surface Anatomy.—Certain important landmarks must be recognised before the skin is reflected from the side of the neck. The sterno-mastoid muscle, pursuing a diagonal course through the space from its antero-inferior to its postero-superior angle, is, perhaps, the most essential of these. By drawing the head well over to the opposite side, it will be rendered evident. The region in front of the sterno-mastoid corresponds to the *anterior triangle* of the neck; that behind it constitutes the *posterior triangle*. Above the notch of the manubrium sterni, and between the sternal tendons of the two sterno-mastoid muscles, the deep suprasternal fossa will be noted. Subjacent to this fossa lies the trachea, but it is only in emaciated individuals that the rings of this tube can be felt distinctly from the surface. In its upper part the trachea is obscured by the isthmus of the thyroid body which crosses it.

The dissector should now run his finger upwards in the middle line of the neck. Beyond the trachea the ring-like cricoid cartilage will be felt. This is a highly important landmark. With it as his guide the surgeon is able to mark out the points at which the trachea or larynx may be opened, and also the level at which the common carotid artery is most favourably placed for the application of a ligature. Above the cricoid cartilage the finger enters the narrow interval between the cricoid and thyroid cartilages—a gap which is occupied by the tense crico-thyroid membrane. In this interval the operation of laryngotomy may be performed.

Next comes the thyroid cartilage with its prominent *pomum Adami*. Beyond the thyroid cartilage is an interval occupied by the thyro-hyoid membrane, and bounded above by the hyoid bone. The body and cornua of the hyoid can be plainly felt from the surface. In the usual attitude of the head the hyoid bone will be observed to be placed on a level with the lower margin of the mandible. Above the hyoid bone, between it and the symphysis of the lower jaw, is the anterior part of the floor of the mouth.

Dissection.—In the first instance merely the structures superficial to the deep cervical fascia should be dissected. A good-sized block being placed under the shoulders of the subject, the head is pulled backwards and the chin dragged over to the opposite side. The parts will be put still further on the stretch if the shoulder be depressed by drawing the arm downwards and then fixing it in this position.

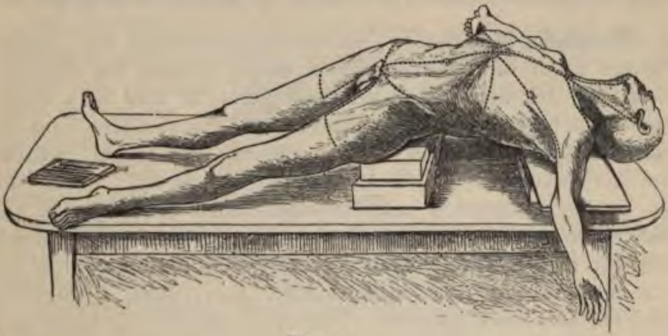

FIG. 75.

For the reflection of the skin three incisions are required, viz.—(1) a vertical incision along the middle line of the neck, from the chin above to the sternum below; (2) a transverse cut from the lower end of the mesial incision outwards along the line of the clavicle to the acromion process of the scapula; (3) an oblique incision, beginning above at the mastoid process behind the ear, and carried downwards and forwards along the anterior border of the sterno-mastoid muscle, until it meets the middle line of the neck at the top of the sternum.

Two triangular flaps of skin, corresponding in a measure to the two triangular areas of the neck, are thus mapped out, and must now be carefully raised. Throw the anterior flap upwards towards the lower jaw, and turn the posterior flap backwards towards the trapezius muscle.

Superficial Fascia.—The superficial fascia in this region contains in its midst the platysma myoides muscle—the representative in the human subject of the panniculus carnosus in the lower animals. In the male, the adipose tissue which distinguishes the superficial fascia is generally very sparse in this locality, so that the fleshy fibres of the muscle are observed shining through it. In females and children the fat is more abundant, giving a fuller and more rounded appearance to the neck. In all cases the fatty tissue is most plentiful between the chin and the hyoid bone, forming in stout individuals the so-called "double-chin."

Dissection.—The fibres of the platysma myoides muscle, which run upwards and forwards, must now be cleaned and its borders defined. In clearing the fatty tissue from its surface, minute nerve filaments will be observed piercing it to reach the skin. These are chiefly branches of the superficial cervical nerve. As the muscle extends downwards on to the front of the chest and upper part of the shoulder, it cannot be fully studied until the dissector of the arm has reflected the skin from these regions.

Platysma Myoides.—This is an exceedingly thin quadrilateral sheet of muscular fibres, which clothes the side and front of the neck, and lies superficial to the deep fascia. Below, it takes origin by scattered and sparse fibres from the skin and subcutaneous fascia covering the upper portions of the pectoralis major and deltoid muscles. From this it proceeds upwards and forwards over the clavicle and acromion, but obtains little or no attachment to these bones. On the side of the neck it decreases somewhat in width, and its fibres being thus more closely aggregated, it becomes thicker and more distinct. Finally, it reaches the lower jaw, into the outer surface of which the majority of the fibres are inserted, many, however, blending with the depressor anguli oris. The anterior fibres decussate below the chin with the corresponding fibres of the opposite muscle, whilst the posterior fibres proceed upwards over the angle of the jaw into the face, and curve forwards towards the angle of the mouth, where they blend with the facial muscles in this locality.

Reflection of the Platysma.—This must be done very carefully, so as not to injure the structures which lie between it and the deep fascia. These are (1) the external and anterior jugular veins; (2) the descending superficial branches of the cervical plexus, which are especially liable to injury as they cross the clavicle and acromion process; (3) the superficial cervical nerve and cervical division of the facial nerve; and (4) the superficial lymphatic glands. The muscle should be raised from below upwards, and left attached by its facial connections.

External Jugular Vein (vena jugularis externa)—Fig. 76 (10).—This is usually a vein of some size. It will be seen emerging from the substance of the parotid gland immediately behind the angle of the lower jaw, where it is formed by the junction of the posterior auricular vein, and posterior division of the temporo-maxillary vein. From this it descends in a nearly vertical direction upon the deep cervical fascia, taking a course which may be mapped out on the surface with tolerable accuracy, by drawing a line from a point behind the angle of the jaw to the middle of the clavicle. It crosses the sterno-mastoid obliquely, and, reaching the posterior margin of this muscle, disappears from view by dipping through the deep cervical fascia immediately above the clavicle. It will subsequently be traced to its termination in the subclavian vein.

Post au
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Shortly after its origin, it effects, as a general rule, a communication with the internal jugular vein, and lower down one or more superficial twigs may connect it with the anterior jugular. Half-way down the neck it is joined by a tributary of some size, which comes from the occipital region and the back of the upper part of the neck; this vein is termed the *posterior external jugular*.

Superficial Cervical Glands.—These form a group of small lymphatic glands which lie along the course of the external jugular vein. They vary from four to six in number.

Anterior Jugular Vein (vena jugularis anterior)—Fig. 76 (23).—The anterior jugular vein is small in comparison with the preceding. It begins by the confluence of some small veins in the sub-maxillary region, and descends vertically at a short distance from the mesial plane. Immediately above the inner end of the clavicle it will be observed to dip through the deep cervical fascia. It terminates by turning abruptly outwards under cover of both heads of the sterno-mastoid muscle, and opening into the external jugular or into the subclavian vein. After it has pierced the fascia, a short transverse branch which crosses the mesial plane connects it with its fellow of the opposite side.

Superficial Branches of the Cervical Plexus.—These all take origin from the second, third, and fourth cervical nerves, and, emerging from under cover of the posterior margin of the sterno-mastoid about its middle, pierce the deep fascia, and arrange themselves into *ascending*, *transverse*, and *descending branches*.

The *ascending branches* are two in number, and both have already been examined in the superficial dissection of the back of the neck (p. 135). They are (*a*) the *small occipital*—Fig. 76 (8),—springing from the second cervical nerve, and (*b*) the *great auricular*—Fig. 76 (5),—which takes origin from the second and third cervical nerves.

The *transverse branches* proceed from a single nerve called the *superficial cervical nerve* (nervus cutaneus colli)—Fig. 76. This arises from the second and third cervical nerves, and, winding round the posterior border of the sterno-mastoid about its middle, proceeds transversely forwards upon the deep fascia to reach the area over the anterior triangle of the neck. Here it divides into two branches, of which one inclines upwards and the other downwards. The *upper branch* communicates freely with the cervical division of the facial nerve, and forms one or more wide loops with it in the region between the hyoid bone and the mandible (Fig. 76). Its branches pierce the platysma and supply the skin as high as the base of the lower jaw. The *lower branch* can be traced as low as the sternum. Its branches also reach the skin by piercing the platysma.

The *descending branches* take origin by a single large trunk from the third and fourth cervical nerves. This emerges from under the posterior border of the sterno-mastoid, and soon breaks up into several twigs, which pierce the deep fascia and spread out widely from each other as they descend over the lower part of the posterior triangle, under cover of the platysma. The ultimate distribution of these twigs is to the integument over the upper part of the front of the chest and over the shoulder. To gain this destination they are carried downwards over the clavicle and acromion process, and are classified into three groups according to their position—viz., (1) *acromial*; (2) *clavicular*; (3) *sternal*—(Fig. 76).

Cervical Division of Facial Nerve.—After emerging from the parotid gland this nerve pierces the deep fascia. It will be found immediately below the angle of the lower jaw. Its branches spread forwards and form a series of loops which extend as low down as the hyoid bone. It is the nerve of supply to the platysma muscle, and effects a free communication with the upper branch of the superficial cervical nerve (Fig. 76).

Deep Cervical Fascia (fascia colli)—Fig. 77.—The cervical fascia should now be cleaned, and its connexions

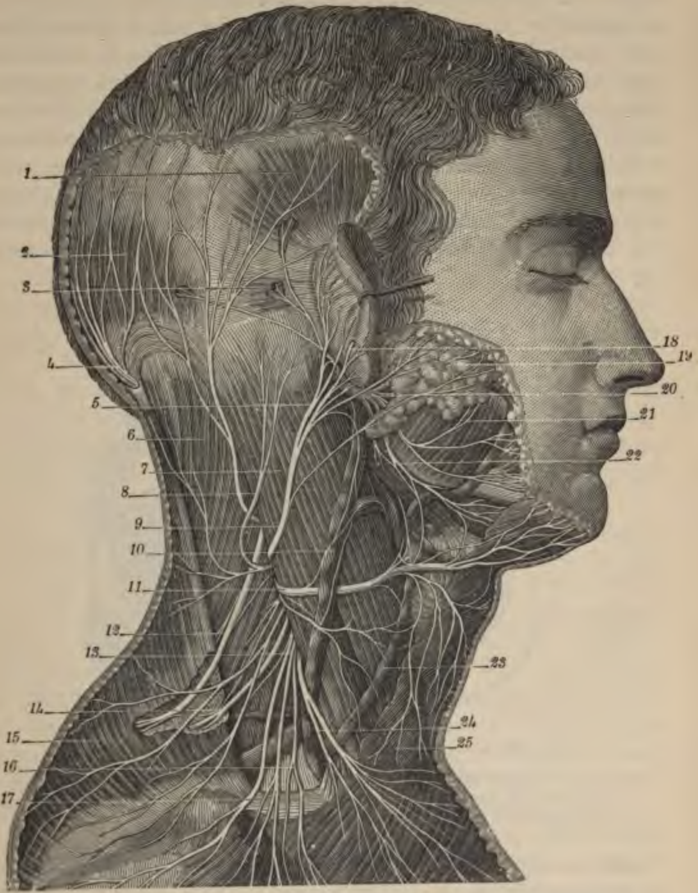


FIG. 76.—Superficial Nerves on the Side of the Neck and Back ot the Scalp. (Hirschfeld and Leveillé.)

1. Attollens auriculam.
2. Posterior belly of occipito-frontalis.
3. Retrahens auriculam.
4. Great occipital nerve.
5. Great auricular nerve.
6. Splenius muscle.
7. Sterno-mastoid muscle.
8. Small occipital nerve (present as two branches).
9. Great auricular nerve.
10. External jugular vein.
11. Superficial cervical nerve.
12. Spinal accessory nerve.
13. Descending branches of cervical plexus.
14. Cervical branches to trapezius.
15. Trapezius muscle.
16. Clavicular branches.
17. Acromial branches.
18. Auricular twigs of great auricular nerve.
19. Parotid gland.
20. Facial nerve.
21. Masseter muscle.
22. Infra-mandibular nerve.
23. Anterior jugular vein.
24. Sternal branches.
25. Platysma myoides.

studied. It constitutes a continuous and strong aponeurotic envelope for the neck, very much in the same manner that the brachial aponeurosis invests the upper arm or the fascia lata the thigh. As in the case of these fasciæ also, processes are given off from its deep surface which penetrate into the neck to form sheaths for the various structures enclosed within the general investment. Certain of these processes stretch across the mesial plane in the form of partitions or septa, which subdivide the neck into fascial compartments. Let us first examine the general envelope as it is at present displayed, and then we shall be in a position to study the more important septa and processes.

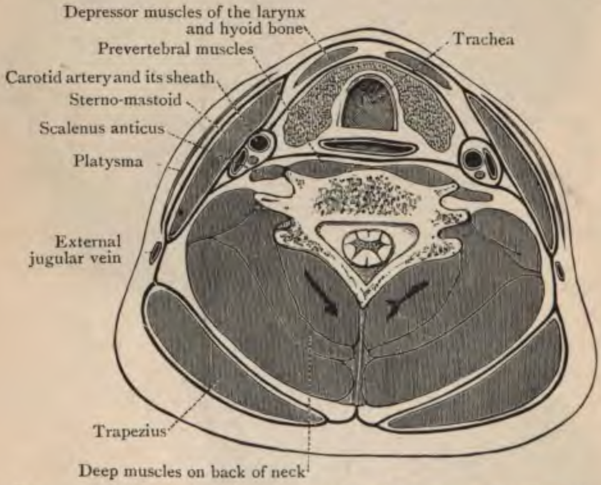

Depressor muscles of the larynx and hyoid bone
Trachea
Prevertebral muscles
Carotid artery and its sheath
Sterno-mastoid
Scalenus anticus
Platysma
External jugular vein
Trapezius
Deep muscles on back of neck

FIG. 77.—Diagrammatic representation of a transverse section through the neck at the level of the isthmus of the thyroid body to show the arrangement of the cervical fascia. (Treves.)

The envelope formed by the deep cervical fascia is not equally developed in all subjects. In many cases, and more especially in females, it is thin and inconspicuous. Neither is it of equal strength at all points. As it stretches over the triangles of the neck, it is distinctly stronger than where it covers either the trapezius or sterno-mastoid. Traced backwards, it splits at the anterior border of the trapezius into two lamellæ to enclose this muscle. The superficial layer is very thin, and both blend posteriorly with the ligamentum nuchæ.

When the investing aponeurosis is followed forwards it is found to split again at the posterior border of the sterno-mastoid into the two lamellæ, which encase that muscle and reunite at its anterior margin. Of these layers the superficial is so delicate that the fleshy fasciculi of the muscle are distinctly seen through it. From the sterno-mastoid the aponeurosis is prolonged over the anterior triangle to the middle line, and passes continuously over to the opposite side of the neck. In its passage, however, from one side to the other, it obtains a firm attachment to the hyoid bone.

Its connexions at the upper and lower limits of the neck may now be examined. *Above*, it is attached along the whole length of the base of the lower jaw. Behind the angle of the jaw it is carried upwards upon the surface of the parotid gland, as the parotid fascia, to gain attachment to the lower margin of the zygoma—a connexion which will be afterwards seen in the dissection of the face. Still farther backwards, it is fixed to the mastoid process, and to the superior curved line of the occipital bone.

Its connexions *below* are no less definite. It is attached to the anterior border of the clavicle, and to the top of the sternum. The latter attachment, however, is of a somewhat intricate character. As the fascia is traced downwards between the two sterno-mastoid muscles, it will be found to split a short distance above the sternum into two layers. Of these, the superficial layer is weak, and is attached to the anterior border of the manubrium sterni. The deeper layer lies immediately in front of the sterno-hyoid and sterno-thyroid muscles, and is fixed below to the posterior border of the manubrium sterni and to the inter-clavicular ligament. Upon either side the two layers unite beyond the sternal head of origin of the sterno-mastoid; and the space between them contains—(1) a little fatty areolar tissue; (2) the two anterior jugular veins for a very short part of their course; (3) the cross branch of communication between the anterior jugular veins of opposite sides when this exists; (4) sometimes a lymphatic gland; and (5) the sternal heads of the sterno-mastoid muscles. Open into the space by dividing the anterior layer close to the sternum, and gauge its extent by means of the handle of the knife.

The *processes* and *partitions* which proceed from the deep surface of the cervical fascia cannot in every case be displayed at the present stage of the dissection, but it is necessary that they should be described, in order that the student may be able to recognise them and appreciate their bearings as they are unfolded in the subsequent dissection of the neck. Those requiring special notice are:—

1. The prevertebral fascia.
2. The pretracheal fascia.
3. The carotid sheath.
4. The stylo-maxillary ligament.

The *prevertebral fascia* is a strong partition which stretches across the neck immediately in front of the vertebral column and the prevertebral muscles. On either side it extends outwards behind the carotid vessels and the internal jugular vein, to obtain attachment to the layer of the investing aponeurosis which lies on the deep surface of the sterno-mastoid muscle. In an upward direction it can be traced to the base of the skull to which it is fixed, whilst below, it passes continuously downwards into the thorax upon the longus colli muscles. The prevertebral fascial septum thus subdivides the investing tube of cervical fascia into—(*a*) a posterior compartment which contains the vertebral column and the muscles which surround it; and (*b*) an anterior or *visceral compartment*, which contains the pharynx, the larynx, the trachea, the gullet, the thyroid body, and the depressor muscles of the larynx and hyoid bone. It is important to note that there is no barrier interposed between this visceral compartment and the superior mediastinal space of the thoracic cavity.

The *pretracheal fascia* is a partition of no great strength, which springs from the deep aspect of the lamella clothing the deep surface of the sterno-mastoid. It passes right across the visceral compartment of the neck in front of the thyroid body and trachea, and behind the anterior belly of the omohyoid, the sterno-thyroid, and sterno-hyoid muscles. It gives off processes which ensheathe the thyroid body and the trachea, and is prolonged downwards into the thorax in front of the great vessels at the root of the neck, to gain an attachment to the fibrous layer of the pericardium.

The great vessels of the neck lie under cover of the sterno-mastoid muscle, and are contained within the outermost part of the visceral compartment on either side of the neck. They are enclosed within a special investment of fascia which receives the name of the *carotid sheath*. Both the prevertebral and the pretracheal septa take part in the formation of this sheath, and in addition to the carotid artery and the internal jugular vein there are included within it the vagus and the descendens hypoglossi nerves. Further, the gangliated cord of the sympathetic may be considered to be embedded in its posterior wall.

The *stylo-maxillary ligament* is a strong process of the cervical fascia in the upper part of the neck, which passes from the angle and posterior margin of the lower jaw to the styloid process. It can readily be exposed at the present stage.

Dissection.—The sterno-mastoid muscle, as we have observed, divides the side of the neck into two triangular spaces—an anterior triangle placed in front of it, and a posterior triangle behind it. This muscle, therefore, should be studied before proceeding further. Carefully clean its superficial surface, and define its attachments. It may also be raised in its lower two-thirds from the subjacent layer of deep cervical fascia. In doing this, care must be taken not to injure the sterno-mastoid branch of the superior thyroid artery which will be seen entering its deep surface. In its upper third it should be left undisturbed in the meantime.

Sterno-Mastoid (sternocleidomastoideus).—The sterno-mastoid muscle takes its origin below by two heads—a sternal and a clavicular. The *sternal head* is rounded, and chiefly tendinous, and springs from the upper part of the anterior face of the manubrium sterni. The *clavicular head* is broad and fleshy, with only a few tendinous fibres intermixed, and it arises from the inner third of the upper surface of the shaft of the clavicle. A narrow interval separates these heads below, but at a higher level the sternal portion overlaps the clavicular, whilst half-way up the neck they both unite into a fleshy mass which ascends to the mastoid process and occiput. Here the muscle expands somewhat. In front, it is thick and tendinous, and is inserted into the fore-part and outer surface of the mastoid process; behind, it is thin and aponeurotic, and is inserted into rather more than the outer half of the superior curved line of the occipital bone. In the dissection of the back, this latter part of the muscle has been detached from the occiput.

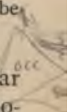
Dissection.—The posterior triangle of the neck should be dissected first. For this purpose the shoulder must be depressed and the head pulled well over to the opposite side and supported upon a block. This interferes, of course, with the dissection of the axilla. It is necessary, therefore, that the dissectors of the head and neck, and of the upper limb, should arrange to work at different hours. Again, the lower part of the posterior triangle, and the upper part of the axilla, constitute a region of the highest importance to both dissectors, seeing that it is here the great blood vessels and nerves leave the root of the neck and enter the arm. Arrangements, therefore, must be made for each to have an opportunity of studying these structures. But in this a difficulty arises. Four days are required to complete the dissection of the axilla, whilst two days are amply sufficient for the dissection of the superficial parts of the neck and the posterior triangle. It is not necessary, however, that the dissector of the head and neck should stop work. After he has displayed the parts in the space as far as he can without dividing the clavicle, he may proceed with the dissection of the anterior triangle, and on the fourth day return to the posterior triangle and complete the work with the co-operation of the dissector of the arm.

The upper part of the posterior triangle has already been displayed in the dissection of the posterior aspect of the neck (p. 137), but the space can only be studied in its entirety when the subject is placed upon its back. The trapezius which has been reflected should be restored as far as possible to its natural position and retained by means of a stitch.

When the investing cervical fascia which bridges over the lower part of the posterior triangle between the trapezius and the sterno-mastoid muscles is removed, a variable amount of fatty areolar tissue is exposed in the supraclavicular region. Embedded within this will be found the transversalis colli and the suprascapular vessels, with the posterior belly of the omo-hyoid muscle and some lymphatic glands. The suprascapular artery emerges from under cover of the sterno-mastoid, and passes outwards immediately subjacent to the clavicle; the transversalis colli artery also comes out from under cover of the sterno-mastoid, but it lies at a higher level. The posterior belly of the omo-hyoid muscle is a narrow muscular band which appears at the angle which is formed by the anterior border of the trapezius muscle and the clavicle, and proceeds forwards and upwards on the side of the neck to disappear under cover of the sterno-mastoid. It should be noted that the posterior belly of the omo-hyoid muscle is enveloped in a sheath of fascia which is loosely disposed around it, and is then prolonged downwards to obtain an attachment to the clavicle. As the muscle disappears under cover of the sterno-mastoid it gives place to a rounded tendon. Upon the under surface of this, closely applied to it, and between the two layers of fascia which invest it, will be found a minute nerve twig which comes from the ansa hypoglossi, and ends in this portion of the omo-hyoid. The lymphatic glands in this region belong to the group which receive the name of *inferior deep cervical glands*. When the fatty areolar tissue is removed from these structures, a strong layer of fascia spread over the subclavian vessels and the brachial nerves will be brought into view.

Deep Layer of Fascia in the Supraclavicular Region.—This is a strong sheet of fascia which is spread over the brachial nerves and the subclavian vessels. When traced inwards under cover of the sterno-mastoid it will be observed to cover the scalenus anticus muscle and to become continuous with the prevertebral fascia and the posterior part of the carotid sheath. In a downward direction it may be followed into the axilla as the sheath of the axillary vessels and nerves, and here it establishes a connection with the costo-coracoid membrane. A distinct space or interval exists between this deep layer of fascia and the investing fascia of the neck. This interval is filled with fatty areolar tissue, and also contains the transversalis colli and suprascapular vessels, the posterior belly of the omo-hyoid muscle, and some of the inferior deep cervical glands. Seeing that the investing cervical fascia is attached to the clavicle, and the deep layer of fascia is more or less intimately connected with the costo-coracoid membrane, the intra-aponeurotic space between them extends downwards for a short distance behind the clavicle. An incision should now be made through the deep layer of fascia as it lies over the great brachial nerves. If the handle of the knife be introduced into this and passed downwards along the course of the nerves behind the fascia, it will be found to proceed with the greatest freedom into the axilla.

Dissection.—The dissector should now proceed with the dissection of the posterior triangle. The deep layer of fascia which is spread over the great vessels and nerves must be removed. The brachial nerves will then be seen emerging from between the scalenus anticus and the scalenus medius muscles. At this stage in the dissection the minute nerve of supply to the subclavius is apt to be injured. It passes vertically downwards upon the superficial aspect of the brachial nerves, and must be secured before they are touched. The brachial nerves are closely matted together by dense connective tissue, which must be removed, but care must be taken at the same time not to injure the branches which spring from them. When the lowest trunk of the brachial plexus is reached the subclavian artery will come into view. This vessel must be thoroughly displayed, and the groove on the first rib on which it lies may be rendered evident by scraping the bone with the handle of the knife. By tracing the external jugular vein downwards, the subclavian vein will be found lying very deeply behind the clavicle. The scalenus anticus muscle, with the phrenic nerve passing downwards upon its anterior surface, will also be observed. Both lie under cover of the sterno-mastoid muscle.



Posterior Triangle.—This is a long, narrow, triangular space placed between the posterior border of the sterno-mastoid and the anterior border of the trapezius. It is covered by the superficial and deep fasciæ of the neck, and also in its lower part by the platysma myoides muscle. Certain cutaneous nerves and the external jugular vein have also been noticed in the superficial fascia which is spread over this area. Near the occiput is the small occipital nerve; near the clavicle are the clavicular descending branches of the cervical plexus, and a very short portion of the external jugular vein.

In front, the posterior triangle is bounded by the posterior margin of the sterno-mastoid, and *behind*, by the anterior margin of the trapezius. The *base* which is below is formed by the middle third of the clavicle, whilst the *apex* which is above is formed by the meeting of the sterno-mastoid and trapezius on the superior curved line of the occipital bone.

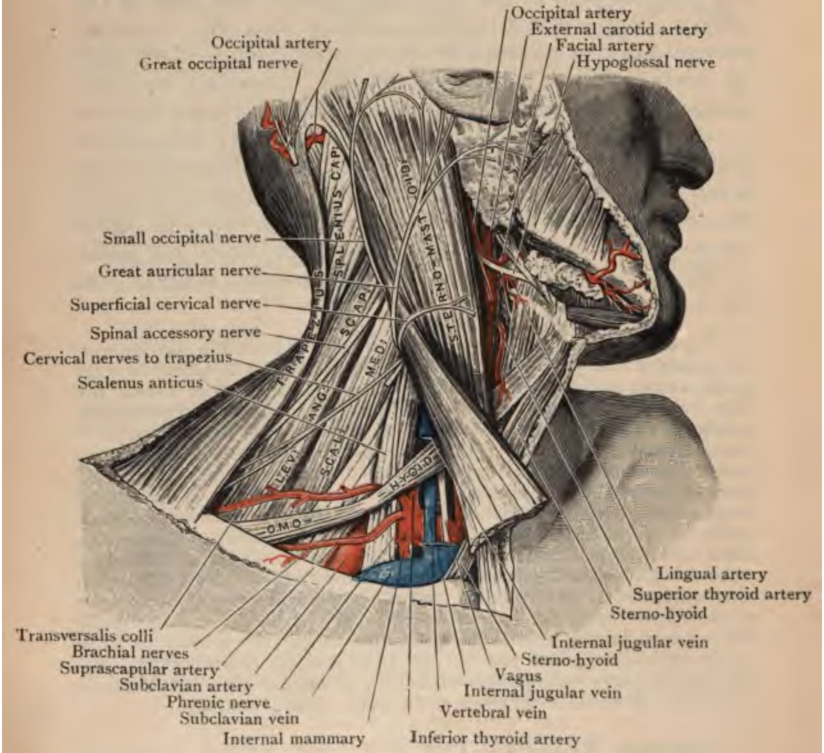

Occipital artery
External carotid artery
Facial artery
Hypoglossal nerve
Occipital artery
Great occipital nerve
SPLENIUS CAP.
O-HYOID
TRAPEZIUS
STERNO-MAST.
SCAP.
MED.
LEV. ANG.
SCAL.
SCAL.
HYOID
OMO
Small occipital nerve
Great auricular nerve
Superficial cervical nerve
Spinal accessory nerve
Cervical nerves to trapezius
Scalenus anticus
Lingual artery
Superior thyroid artery
Sterno-hyoid
Internal jugular vein
Sterno-hyoid
Vagus
Internal jugular vein
Vertebral vein
Inferior thyroid artery
Transversalis colli
Brachial nerves
Suprascapular artery
Subclavian artery
Phrenic nerve
Subclavian vein
Internal mammary

FIG. 78.—Dissection of the Posterior Triangle of the Neck.

The posterior belly of the omo-hyoid, which crosses the lower part of the posterior triangular space, subdivides it into an upper portion called the occipital triangle, and a lower part termed the supraclavicular or subclavian triangle.

Occipital Triangle.—The occipital or upper triangle is much the larger subdivision. It is bounded in front by the sterno-mastoid; behind by the trapezius; whilst its base is formed by the omo-hyoid.

Within the limits of the occipital triangle we find the following structures:—

1. The *occipital artery* in a very small part of its course, and only when the sterno-mastoid fails to meet the trapezius at the apex of the triangle.
2. The spinal accessory nerve.
3. The branches from the third and fourth cervical nerves which cross the space to supply the trapezius muscle.
4. The superficial branches of the cervical plexus as they appear at the posterior border of the sterno-mastoid previous to piercing the deep fascia.
5. Branches of supply to the levator anguli scapulæ from the third and fourth cervical nerves.
6. The transversalis colli artery and vein, which cross the lower part of the space.
7. The upper part of the brachial plexus of nerves.

The contents of the occipital triangle have already in a great measure been studied (p. 137).

Supraclavicular Triangle.—The supraclavicular or subclavian triangle is a very small space. It is bounded above by the omo-hyoid; below by the clavicle; and in front by the sterno-mastoid. The area thus circumscribed is very variable in its extent in different subjects. Indeed, in the natural position of parts, the posterior belly of the omo-hyoid passes forwards so close to the clavicle that a very small interval is left between them, and it is only after the fascial connexions of the muscle have been divided that the triangle becomes well marked.

Cases also occur in which the omo-hyoid takes partial or complete origin from the clavicle, and thus the supraclavicular space is still further reduced in size. Another condition which materially affects the dimensions of the supraclavicular triangle is the muscular development of the subject. The more powerful the neck, the more extensive are the attachments of the trapezius and sterno-mastoid to the clavicle, and the narrower in consequence is the triangle. In a few instances these muscles will be observed to meet on the clavicle, and thus obliterate the space altogether. This latter condition, however, is not necessarily associated with a specially high development of the muscles.

In the supraclavicular space a great number of highly important structures are collected together within a very limited area. The great blood vessels and nerves which pass from the neck to the upper limb traverse this space. Its contents are the following:—

- Arteries
  - Subclavian.
  - Transversalis colli.
  - Suprascapular.
- Veins
  - External jugular.
  - Suprascapular.
  - Transversalis colli.
  - Subclavian.
- Nerves—The trunks of the brachial plexus and their branches.
- Lymphatic glands.

Subclavian Artery (arteria subclavia).—It is only the *third part* of the subclavian artery which is included in the supraclavicular triangle. This portion of the vessel extends from the outer margin of the scalenus anticus to the outer border of the first rib. Here it enters the axilla and becomes the axillary artery. It takes a very oblique course; at first it lies at a variable distance above the level of the clavicle; but as it runs from above downwards and outwards, it finally comes to lie behind the clavicle and the subclavius muscle.

It is this portion of the artery that the surgeon selects, when the choice lies in his own hands, as the seat for applying a ligature. Its relations, therefore, must be studied with especial care.

In front of the vessel are the coverings of the space in which it lies—viz., superficial fascia, platysma, superficial descending clavicular branches of the cervical plexus, and the deep cervical fascia. Towards its termination, however, as we have seen, it passes behind the clavicle and subclavius muscle, and here also it is crossed by the suprascapular artery. But perhaps the most important anterior relation, and one which, in tying the vessel, may somewhat embarrass the surgeon, is that established by the external jugular vein and certain of its tributaries. This vein crosses in front of the artery close to the scalenus anticus, and whilst occupying this position, two, or it may be three, tributaries join it—viz., the transversalis colli, the suprascapular, and the anterior jugular veins. Observe further that the small nerve to the subclavius is carried vertically downwards in front of the artery behind the veins.

Below, the third part of the subclavian artery rests upon the first rib; at *a higher level*, and also emerging from under cover of the scalenus anticus, are the brachial nerves. *Behind*, the vessel is in contact with the scalenus medius, although the lowest brachial nerve trunk may intervene between the muscle and the artery. The *subclavian vein* is placed at a lower level than the artery, and on a plane slightly anterior to it.

Although, as a rule, no branch springs from this portion of the subclavian, it is not uncommon to find the *posterior scapular artery* taking direct origin from its upper surface.

Surgical Anatomy.—The dissector should again examine the relations of the subclavian artery, with the view of determining those which would constitute the most trustworthy guides in cases where it is necessary to apply a ligature to its third part. He should note that the posterior belly of the omo-hyoid will give no information beyond that of the *depth* at which the operator has arrived. The true guide is the *outer border of the scalenus anticus muscle*. This, as a rule, lies immediately subjacent to the posterior margin of the sterno-mastoid. By passing the forefinger downwards along the outer margin of the scalenus anticus, the *scalene tubercle* on the first rib will be reached. When the finger-nail rests on this tubercle the finger-pulp is applied to the artery, and in the living subject will feel its pulsations.

Suprascapular and Transversalis Colli Arteries.—Both of these arteries will be observed emerging from under cover of the outer border of the sterno-mastoid. Their origin from the thyroid axis will be seen in a subsequent dissection.

The *suprascapular artery* (arteria transversa scapulæ) proceeds outwards under shelter of the clavicle and across the third part of the subclavian artery and the brachial nerves. At the outer limit of the supraclavicular triangle it passes under cover of the trapezius to reach the superior border of the scapula where it has already been examined (p. 139). The *transversalis colli* (arteria transversa colli) is placed at a higher level, and is carried outwards across the posterior triangle. It passes under cover of the posterior belly of the omo-hyoid, and, as a rule, superficial to the brachial nerves. It has already been observed to end under cover of the anterior margin of the trapezius, by dividing into the posterior scapular and the superficial cervical arteries (p. 138).

Veins.—The arrangement of the veins has been noticed in studying the relations of the subclavian artery. The *external jugular vein*, as a rule, crosses the third part of this artery at the outer border of the scalenus anticus and joins the subclavian vein. It is joined close to its termination by the suprascapular and transversalis colli veins, and perhaps by the anterior jugular as it emerges from under cover of the sterno-mastoid. In certain cases, however, the anterior jugular joins the subclavian vein directly.

Floor of the Posterior Triangle.—The floor of the posterior triangular space is formed by a succession of muscles, and at its very lowest part by a small portion of the first rib. In the *occipital subdivision* the dissector will observe that the floor is constituted from above downwards by—(1) the splenius capitis; (2) the levator anguli scapulæ; and (3) by the scalenus medius and posticus. At the apex of the triangle an additional factor may sometimes be observed—viz., a small portion of the complexus.

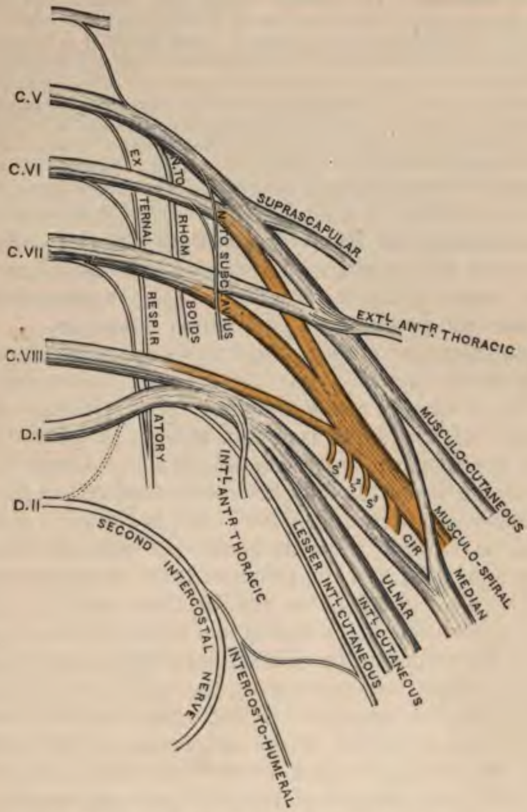

C.V
C.VI
C.VII
C.VIII
D.I
D.II
EXTERNAL RESPIRATORY
N. TO RHOMBOIDS
N. TO SUBCLAVIUS
SUPRASCAPULAR
EXTL ANTR THORACIC
MUSCULO-CUTANEOUS
S1
S2
S3
CIR
MUSCULO-SPIRAL
MEDIAN
ULNAR
INTL CUTANEOUS
LESSER INTL CUTANEOUS
INTL ANTR THORACIC
SECOND INTERCOSTAL NERVE
INTERCOSTO-HUMERAL

FIG. 79.—Diagram of the Brachial Plexus.

S^1, S^2, S^3.—The three subscapular nerves. Cir.—Circumflex nerve.

In the *supraclavicular triangle* the floor lies very deeply. It is formed by the scalenus medius and posticus, a portion of the first rib, and a small part of the first digitation of the serratus magnus muscle.

Section of the Clavicle.—In order that a satisfactory view may be obtained of the nerves forming the brachial plexus, it is necessary to remove the middle third of the clavicle. This, of course, can only be done when the dissector of the upper limb has completed the dissection of the axilla. Saw through the clavicle at two points—viz., at the posterior margin of the sterno-mastoid, and the anterior margin of the trapezius—and remove the intermediate piece of bone, after having carefully detached it from the subclavius. The nerve to the subclavius should now be traced to its distribution. Then divide the fibres of the subclavius which still adhere to the acromial third of the clavicle, and throw the muscle inwards. This will allow the shoulder to drop well backwards.

Brachial Plexus.—This great nerve plexus is formed by the anterior primary divisions of the four lower cervical nerves and the greater part of the large anterior primary division of the first dorsal nerve. Above, the plexus is further reinforced by a very small twig of communication which passes from the fourth to the fifth cervical nerve; whilst below, a similar connecting twig not infrequently passes upwards in front of the neck of the second rib from the second to the first dorsal nerve. The four lower cervical nerves are brought into connection with the middle and inferior ganglia of the cervical sympathetic by means of fine grey rami communicantes.

The great brachial nerves emerge from the interval between the scalenus anticus and scalenus medius, and proceed downwards and outwards through the lower part of the posterior triangle towards the axilla. The manner in which they unite to form the plexus is upon the whole very constant. The *fifth* and *sixth* nerves unite to form an *upper trunk*; the *seventh* nerve remains single and proceeds downwards as a *middle trunk*; and the *eighth cervical* and *first dorsal* nerves join, whilst still under cover of the scalenus anticus, to constitute a third or *lower trunk*. Whilst still within the posterior triangle of the neck, each trunk splits into an *anterior* and a *posterior division*. Raise the three anterior divisions on the handle of the knife, and then it will be seen that the three posterior divisions unite to form the *posterior cord* of the plexus, and, further, that the innermost of these divisions is much smaller than the other two. Of the three anterior divisions, the *outer two* join to constitute the *outer cord*, whilst the *innermost* is carried down by itself as the *inner cord* of the plexus. From the three cords of the brachial plexus are given off the branches which supply the upper limb.

From the above description it will be seen that the plexus, from changes which are effected in the arrangement of its fibres, may be divided into four stages:—

1st Stage.	2nd Stage.	3rd Stage.	4th Stage.
5 separate nerves (viz., 4 lower cervical and first dorsal).	3 nerve trunks (viz., an upper, middle, and lower).	3 anterior divisions and 3 posterior divisions.	3 nerve cords (viz., an outer, inner, and a posterior).

The first three of these stages are generally observed in the lower part of the posterior triangle and in the upper part of the axilla. It must be understood, however, that the points at which division and union of the different parts of the plexus takes place are subject to considerable variation.

Supraclavicular Branches of the Brachial Plexus.—The only branches of the brachial plexus which fall to the lot of the dissector of the head and neck are those given off above the level of the clavicle. These are for the most part destined for the supply of muscles in the neighbourhood. They are:—

1. Nerve to rhomboids,	from the 5th cervical nerve.
2. Nerve to subclavius,	from the 5th and 6th cervical nerves.
3. Suprascapular,	
4. External respiratory nerve of Bell,	from the 5th, 6th, and 7th cervical nerves.
5. Twigs to scalene muscles and longus colli,	from the lower four cervical nerves close to the intervertebral foramina.
6. Communicating twig to phrenic nerve,	from 5th cervical.

The *nerve to the rhomboids* (nervus dorsalis scapulæ) is a long slender branch which springs, by a stem common to it and the uppermost root of the nerve of Bell, from the back of the fifth cervical nerve as it lies upon the scalenus medius. Draw the fifth cervical nerve forwards, and the branch in question will be seen passing backwards through the fibres of that muscle to reach the deep surface of the levator anguli scapulæ. It here meets the posterior scapular artery, and proceeds with it downwards under cover of the rhomboid muscles close to the base of the scapula. It supplies one or two twigs to the levator anguli scapulæ, and is finally exhausted in the rhomboids.

The *nerve to the subclavius* (nervus subclavius) is a minute twig which springs from the front of the upper trunk of the plexus, and then passes vertically downwards upon the plexus, and across the subclavian artery to the subclavius muscle, which it reaches by piercing the posterior lamina of its sheath.

A communication between the nerve to the subclavius and the phrenic is by no means uncommon. This connecting filament may join the phrenic in the neck or in the thorax. In all probability, it represents that communicating twig (or at least a portion of it) which, on other occasions, passes directly from the fifth cervical nerve to the phrenic.

The *suprascapular nerve* (nervus suprascapularis) is the largest branch given off above the clavicle. It springs from the back of the upper trunk of the plexus, and runs downwards, outwards, and backwards, at a higher level than the brachial nerves, to the suprascapular notch of the scapula, through which it enters the supraspinous fossa. As it approaches the scapula, it passes under cover of the trapezius and posterior belly of the omo-hyoid, and comes into relation with the artery of the same name.

The *external respiratory nerve of Bell*, also called the *posterior thoracic* (nervus thoracicalis longus), is formed by the union of three roots which arise from the back of the fifth, sixth, and seventh cervical nerves close to the intervertebral foramina. The roots from the fifth and sixth cervical nerves pass backwards through the fibres of the scalenus medius, and unite into one stem which gives branches to the upper part of the serratus magnus. The third root from the seventh cervical nerve does not pierce the scalenus medius. It is carried downwards on the surface of that muscle, and ultimately joins the stem formed by the union of the upper two roots. The posterior thoracic nerve enters the axilla behind the axillary vessels, and is entirely devoted to the supply of the serratus magnus muscle.

Dissection.—At this stage, the dissector of the upper limb removes the arm from the trunk. The dissector of the head and neck must see that the vessels and nerves are not cut too short. The outer border of the first rib is the level at which they should be divided.

The dissector should now proceed with the dissection of the anterior triangle. In this dissection the visceral compartment of the neck is opened up, and its contents displayed. Let the head hang well over the end of the table, and, raising the lower jaw as much as possible, fix it in this position by means of hooks. Begin the dissection by throwing the superficial cervical nerve and the cervical division of the facial nerve backwards, and then carefully raise the cervical fascia from the area in front of the

In front, the posterior triangle is bounded by the posterior margin of the sterno-mastoid, and *behind*, by the anterior margin of the trapezius. The *base* which is below is formed by the middle third of the clavicle, whilst the *apex* which is above is formed by the meeting of the sterno-mastoid and trapezius on the superior curved line of the occipital bone.

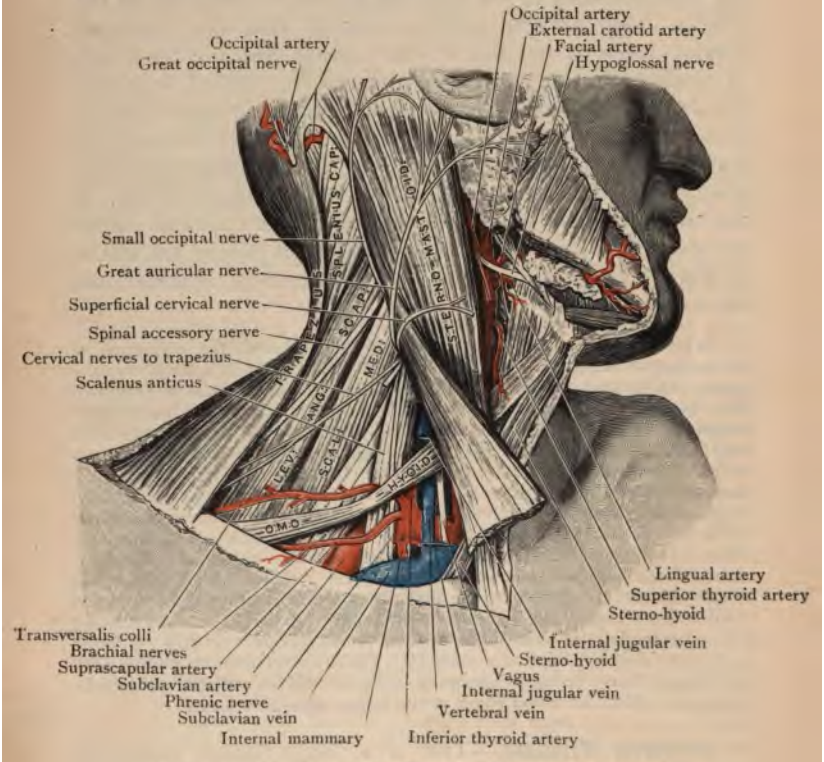

Occipital artery
External carotid artery
Facial artery
Hypoglossal nerve
Occipital artery
Great occipital nerve
Small occipital nerve
Great auricular nerve
Superficial cervical nerve
Spinal accessory nerve
Cervical nerves to trapezius
Scalenus anticus
SPLENIUS CAP.
TRAPEZIUS
STERNO-MAST
OID.
LEV. ANG. SCAP.
SCAL. MEDI.
OMO-
HYOID
Lingual artery
Superior thyroid artery
Sterno-hyoid
Internal jugular vein
Sterno-hyoid
Vagus
Internal jugular vein
Vertebral vein
Inferior thyroid artery
Transversalis colli
Brachial nerves
Suprascapular artery
Subclavian artery
Phrenic nerve
Subclavian vein
Internal mammary

FIG. 78.—Dissection of the Posterior Triangle of the Neck.

The posterior belly of the omo-hyoid, which crosses the lower part of the posterior triangular space, subdivides it into an upper portion called the occipital triangle, and a lower part termed the supraclavicular or subclavian triangle.

Occipital Triangle.—The occipital or upper triangle is much the larger subdivision. It is bounded in front by the sterno-mastoid; behind by the trapezius; whilst its base is formed by the omo-hyoid.

Within the limits of the occipital triangle we find the following structures:—

1. The *occipital artery* in a very small part of its course, and only when the sterno-mastoid fails to meet the trapezius at the apex of the triangle.
2. The spinal accessory nerve.
3. The branches from the third and fourth cervical nerves which cross the space to supply the trapezius muscle.
4. The superficial branches of the cervical plexus as they appear at the posterior border of the sterno-mastoid previous to piercing the deep fascia.
5. Branches of supply to the levator anguli scapulæ from the third and fourth cervical nerves.
6. The transversalis colli artery and vein, which cross the lower part of the space.
7. The upper part of the brachial plexus of nerves.

The contents of the occipital triangle have already in a great measure been studied (p. 137).

Supraclavicular Triangle.—The supraclavicular or subclavian triangle is a very small space. It is bounded above by the omo-hyoid; below by the clavicle; and in front by the sterno-mastoid. The area thus circumscribed is very variable in its extent in different subjects. Indeed, in the natural position of parts, the posterior belly of the omo-hyoid passes forwards so close to the clavicle that a very small interval is left between them, and it is only after the fascial connexions of the muscle have been divided that the triangle becomes well marked.

Cases also occur in which the omo-hyoid takes partial or complete origin from the clavicle, and thus the supraclavicular space is still further reduced in size. Another condition which materially affects the dimensions of the supraclavicular triangle is the muscular development of the subject. The more powerful the neck, the more extensive are the attachments of the trapezius and sterno-mastoid to the clavicle, and the narrower in consequence is the triangle. In a few instances these muscles will be observed to meet on the clavicle, and thus obliterate the space altogether. This latter condition, however, is not necessarily associated with a specially high development of the muscles.

In the supraclavicular space a great number of highly important structures are collected together within a very limited area. The great blood vessels and nerves which pass from the neck to the upper limb traverse this space. Its contents are the following:—

- Arteries
  - Subclavian.
  - Transversalis colli.
  - Suprascapular.
- Veins
  - External jugular.
  - Suprascapular.
  - Transversalis colli.
  - Subclavian.
- Nerves—The trunks of the brachial plexus and their branches.
- Lymphatic glands.

Subclavian Artery (arteria subclavia).—It is only the *third part* of the subclavian artery which is included in the supraclavicular triangle. This portion of the vessel extends from the outer margin of the scalenus anticus to the outer border of the first rib. Here it enters the axilla and becomes the axillary artery. It takes a very oblique course; at first it lies at a variable distance above the level of the clavicle; but as it runs from above downwards and outwards, it finally comes to lie behind the clavicle and the subclavius muscle.

It is this portion of the artery that the surgeon selects, when the choice lies in his own hands, as the seat for applying a ligature. Its relations, therefore, must be studied with especial care.

In front of the vessel are the coverings of the space in which it lies—viz., superficial fascia, platysma, superficial descending clavicular branches of the cervical plexus, and the deep cervical fascia. Towards its termination, however, as we have seen, it passes behind the clavicle and subclavius muscle, and here also it is crossed by the suprascapular artery. But perhaps the most important anterior relation, and one which, in tying the vessel, may somewhat embarrass the surgeon, is that established by the external jugular vein and certain of its tributaries. This vein crosses in front of the artery close to the scalenus anticus, and whilst occupying this position, two, or it may be three, tributaries join it—viz., the transversalis colli, the suprascapular, and the anterior jugular veins. Observe further that the small nerve to the subclavius is carried vertically downwards in front of the artery behind the veins.

Below, the third part of the subclavian artery rests upon the first rib; at *a higher level*, and also emerging from under cover of the scalenus anticus, are the brachial nerves. *Behind*, the vessel is in contact with the scalenus medius, although the lowest brachial nerve trunk may intervene between the muscle and the artery. The *subclavian vein* is placed at a lower level than the artery, and on a plane slightly anterior to it.

Although, as a rule, no branch springs from this portion of the subclavian, it is not uncommon to find the *posterior scapular artery* taking direct origin from its upper surface.

Surgical Anatomy.—The dissector should again examine the relations of the subclavian artery, with the view of determining those which would constitute the most trustworthy guides in cases where it is necessary to apply a ligature to its third part. He should note that the posterior belly of the omo-hyoid will give no information beyond that of the *depth* at which the operator has arrived. The true guide is the *outer border of the scalenus anticus muscle.* This, as a rule, lies immediately subjacent to the posterior margin of the sterno-mastoid. By passing the forefinger downwards along the outer margin of the scalenus anticus, the *scalene tubercle* on the first rib will be reached. When the finger-nail rests on this tubercle the finger-pulp is applied to the artery, and in the living subject will feel its pulsations.

Suprascapular and Transversalis Colli Arteries.—Both of these arteries will be observed emerging from under cover of the outer border of the sterno-mastoid. Their origin from the thyroid axis will be seen in a subsequent dissection.

The *suprascapular artery* (arteria transversa scapulæ) proceeds outwards under shelter of the clavicle and across the third part of the subclavian artery and the brachial nerves. At the outer limit of the supraclavicular triangle it passes under cover of the trapezius to reach the superior border of the scapula where it has already been examined (p. 139). The *transversalis colli* (arteria transversa colli) is placed at a higher level, and is carried outwards across the posterior triangle. It passes under cover of the posterior belly of the omo-hyoid, and, as a rule, superficial to the brachial nerves. It has already been observed to end under cover of the anterior margin of the trapezius, by dividing into the posterior scapular and the superficial cervical arteries (p. 138).

Veins.—The arrangement of the veins has been noticed in studying the relations of the subclavian artery. The *external jugular vein*, as a rule, crosses the third part of this artery at the outer border of the scalenus anticus and joins the subclavian vein. It is joined close to its termination by the suprascapular and transversalis colli veins, and perhaps by the anterior jugular as it emerges from under cover of the sterno-mastoid. In certain cases, however, the anterior jugular joins the subclavian vein directly.

Floor of the Posterior Triangle.—The floor of the posterior triangular space is formed by a succession of muscles, and at its very lowest part by a small portion of the first rib. In the *occipital subdivision* the dissector will observe that the floor carotid sheath should be slit open, care being taken of the descendens hypoglossi nerve, which also descends obliquely within it. The intimate connexion which this sheath presents with the prevertebral layer of fascia can now be made out. The common carotid usually bifurcates opposite the upper border of the thyroid cartilage. Observe that the internal carotid artery at first lies *behind, and to the outer side* of the external carotid. Upon the coats of these vessels numerous sympathetic twigs ramify, and, at the point of bifurcation of the common carotid, a small oval body, termed the *carotid body*, will be found closely applied to the deep surface of the vessel. The branches of the external carotid which take origin in the area of this triangle run for only a very short part of their course within it. Three branches will be noticed springing from the anterior aspect of the external carotid. Named from below upwards these are: (1) the *superior thyroid artery*, which, after having given off its *hyoid*, *superior laryngeal*, and *sterno-mastoid branches*, disappears under cover of the omo-hyoid muscle, and enters the muscular triangle; (2) the *lingual artery*, which forms a small loop or arch above the great cornu of the hyoid bone and leaves the space by passing under cover of the digastric and stylo-hyoid muscles; and (3) the *facial artery*, which ascends under the same muscles to gain the digastric triangle. The *occipital artery* commonly springs from the posterior aspect of the external carotid close to the lower border of the digastric, and soon quits the space by running upwards and backwards under cover of the sterno-mastoid muscle. The *sterno-mastoid branch* of the occipital artery comes off as the latter leaves the triangle, and accompanies the spinal accessory nerve. The *ascending pharyngeal artery* will be found by separating the external and internal carotid arteries from each other, and dissecting between them. It springs from the posterior aspect of the former about half an inch above its origin, and then takes a vertical course upwards on the prevertebral muscles.

The *internal jugular vein*, which from a surgical point of view is the most important structure in the anterior triangle of the neck, lies close to the outer side of the common carotid artery, and is included within the same fascial sheath. Several tributaries join it as it passes through the carotid triangle. The most conspicuous of these is the *common facial* *vein*, which is formed by the union of the facial vein and the anterior division of the temporo-maxillary vein. The common facial vein enters the internal jugular at the level of the hyoid bone, and certain lymphatic glands which overlie the veins at this point are of especial importance, seeing that they are frequently the seat of tubercular disease (Stiles).

The nerves which are brought into view as the carotid triangle is gradually opened up are very numerous, but they can be classified according to the direction which they take through the space. One large nerve, the *hypoglossal*, takes a more or less *transverse* course across the upper part of the space. It forms a loop across this part of the neck immediately below the lower margin of the digastric muscle. Two descend *vertically*—viz., the vagus and the gangliated cord of the sympathetic. The *vagus* lies in the posterior part of the carotid sheath between the common carotid artery and the internal jugular vein. The *sympathetic cord* is embedded in the posterior wall of the carotid sheath. The remaining five nerves traverse the triangle obliquely. Four run from above downwards and forwards, viz., the descendens hypoglossi, the thyro-hyoid, the internal and external laryngeal nerves; and one—the spinal accessory—is directed from above downwards and backwards.

The *descendens hypoglossi* springs from the hypoglossal nerve as it hooks round the occipital artery, and descends within the carotid sheath. It is joined at the upper border of the omo-hyoid by one or two branches from the cervical plexus, and in this manner the *ansa hypoglossi* is formed. The *thyro-hyoid* is a minute nerve which arises from the hypoglossal nerve before it disappears under cover of the posterior belly of the digastric. The *internal laryngeal nerve* descends behind the carotid vessels. It will be readily found, with the corresponding artery, in the interval between the hyoid bone and upper border of the thyroid cartilage. It enters the larynx by piercing the thyro-hyoid membrane. The *external laryngeal nerve* is a much smaller twig. It leaves the space by passing under cover of the depressor muscles of the larynx and hyoid bone. The *spinal accessory nerve* is placed high up in the interval between the digastric and the sterno-mastoid muscles. It soon disappears by sinking into the substance of the sterno-mastoid about one and a half inches below the tip of the mastoid process.

Digastric Triangle.—The digastric space may be divided very conveniently into an anterior and posterior part by the stylo-maxillary ligament and a line drawn downwards from it. The portion in front has a distinct floor, composed, in great part, by the mylo-hyoid muscle, and behind this by a portion of the hyoglossus muscle.

The parts exposed during the dissection of the digastric space may be classified according to the subdivision in which they lie :—

Anterior Part.	Posterior Part.
1. Submaxillary gland. 2. Facial artery and vein. 3. Hypoglossal nerve. 4. Mylo-hyoid nerve. 5. Mylo-hyoid artery. 6. Lymphatic glands.	1. Portion of the parotid gland. 2. External carotid artery. 3. Posterior auricular artery.

The most conspicuous object in the fore-part of the digastric triangle is the *submaxillary gland.* The *facial artery* passes first upwards and then forwards in the midst of this gland, whilst the *facial vein* lies superficial to it. But whilst the facial artery runs through the gland, the dissector should note that it can be separated from it without any laceration of the gland lobules. The gland is, as it were, wrapped round it, so that, although at first sight the artery seems to pierce it, it is in reality merely contained in a deep furrow in its substance. Before entering the gland, the facial artery gives off its *tonsillitic* and *ascending palatine branches,* whilst its *submental* and *submaxillary branches* arise within the gland. The submental artery runs forwards towards the chin. The *mylo-hyoid nerve* and *artery* will be seen passing forwards and downwards upon the mylo-hyoid muscle under cover of the submaxillary gland. The twigs of the nerve to the muscle of the same name and to the anterior belly of the digastric should be followed out. Only a very small part of the *hypoglossal nerve* is seen in this space. It lies upon the hyoglossus muscle immediately above the hyoid bone, and disappears under cover of the posterior border of the mylo-hyoid muscle. Numerous small *lymphatic glands* lie under shelter of the base of the lower jaw. They receive their afferent vessels from the tongue, teeth, and face.

The *external carotid artery* enters the posterior part of the digastric triangle. Here it lies under cover of the lower part of the parotid gland, and gives off its *posterior auricular branch*, which passes upwards and backwards along the upper border of the posterior belly of the digastric muscle.

Middle Line of the Neck.—Before the parts are further disturbed the dissector should examine the structures which occupy the middle line of the neck—a region, more especially in its lower part, of the highest importance and interest to the surgeon. The middle line of the neck may be divided by means of the hyoid bone into an upper supra-hyoid and a lower infra-hyoid portion.

In the *supra-hyoid part* are found structures which are concerned in the construction of the floor of the mouth. The student has already noticed that the fatty superficial fascia is more fully developed here than elsewhere in the neck, and that the anterior margins of the two platysma muscles meet in the mesial plane about half an inch or so below the chin. Above this point their fibres decussate. In the present condition of parts the two anterior bellies of the digastric muscles are observed attached to the mandible on either side of the symphysis. From this they descend towards the hyoid bone, and diverge slighlty from each other so as to leave a narrow triangular space, termed the *submental triangle*, between them (Fig. 81). The floor of this space is formed by the anterior portions of the two mylo-hyoid muscles, whilst bisecting the triangle in the mesial plane is the fibrous raphe, into which these muscles are inserted. Not infrequently the inner margins of the digastric muscles send decussating fibres across the interval between them. Within the submental triangle are the *supra-hyoid glands*, which lie above the body of the hyoid bone and are not infrequently the seat of abscess following impetigo of the lower lip.

The *infra-hyoid part* of the middle line of the neck extends from the hyoid bone to the upper margin of the manubrium sterni. Below the hyoid bone is the thyro-hyoid membrane succeeded by the thyroid cartilage with its prominent *pomum Adami*. Then comes the tense crico-thyroid membrane and the cricoid cartilage. Except along a narrow interval on either side of the mesial plane, these structures are covered by two muscular strata, viz., a superficial layer formed by the sterno-hyoid and omo-hyoid which lie on the same plane, and a deeper layer formed by the sterno-thyroid and its continuation upwards, the thyro-hyoid. In addition to these an elongated process of the thyroid gland not infrequently stretches upwards (usually upon the left side), under cover of the sterno-hyoid. If this be present, it will in all probability be observed to be attached to the hyoid bone by a narrow muscular band termed the *levator glandulæ thyroideæ*. The divergent inner margins of the two small crico-thyroid muscles, as they extend upwards and outwards upon the cricoid cartilage towards the lower margin of the thyroid

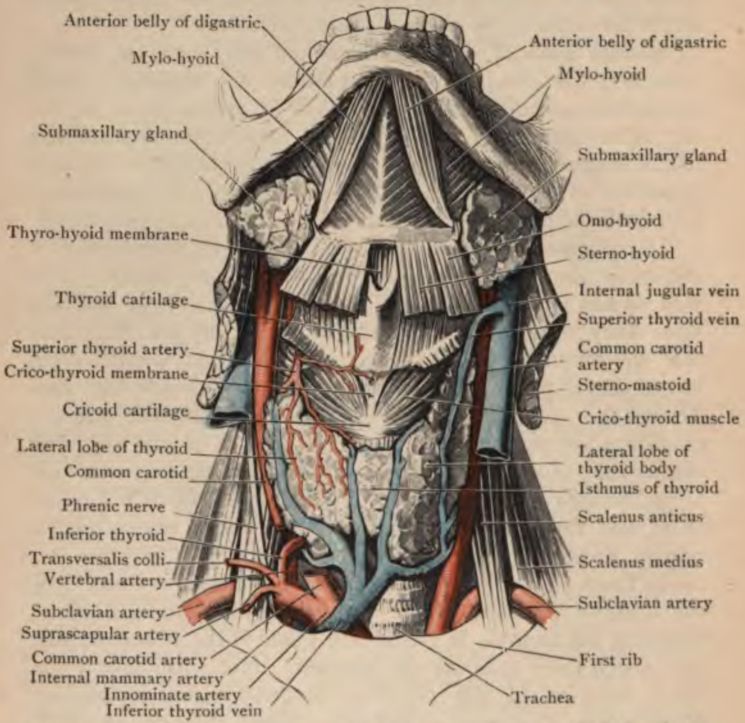

Anterior belly of digastric
Mylo-hyoid
Submaxillary gland
Thyro-hyoid membrane
Thyroid cartilage
Superior thyroid artery
Crico-thyroid membrane
Cricoid cartilage
Lateral lobe of thyroid
Common carotid
Phrenic nerve
Inferior thyroid
Transversalis colli
Vertebral artery
Subclavian artery
Suprascapular artery
Common carotid artery
Internal mammary artery
Innominate artery
Inferior thyroid vein
Anterior belly of digastric
Mylo-hyoid
Submaxillary gland
Omo-hyoid
Sterno-hyoid
Internal jugular vein
Superior thyroid vein
Common carotid artery
Sterno-mastoid
Crico-thyroid muscle
Lateral lobe of thyroid body
Isthmus of thyroid
Scalenus anticus
Scalenus medius
Subclavian artery
First rib
Trachea

FIG. 81.—Dissection of the Front of the Neck. The lower portions of the sterno-mastoid muscles have been removed, and the lower part of the right common carotid artery cut away to show the deeper parts.

cartilage, will also be seen. Upon the crico-thyroid membrane, as it appears between these muscles, the small crico-thyroid artery runs transversely inwards.

Below the cricoid cartilage the dissector comes upon the trachea, which extends downwards through the remaining portion of the middle of the neck. As the tube descends it gradually recedes from the surface, so that at the upper margin of the sternum it lies very deeply. The length of this portion of the trachea varies with the position of the head. When the chin is raised, and the head thrown as far back as possible, about two inches and three-quarters of the tube will be found between the cricoid cartilage and the sternum; when, on the other hand, the head is held in its usual attitude, the length of the cervical part of the trachea is diminished by fully three-quarters of an inch or even more. These measurements must be regarded as merely expressing the average condition. They vary considerably in different individuals, and are much influenced by differences in the length of the neck.

The dissector must study carefully the parts which lie superficial to the trachea in this portion of its course. In the first place, examine the structures which are in immediate contact with it. These are: (1) the isthmus of the thyroid body; (2) the inferior thyroid veins; (3) at the root of the neck, the innominate artery and the left innominate vein; (4) the thymus body in young children; and (5) the occasional thyroidea ima artery. The *isthmus of the thyroid* is a thin band of thyroid substance which crosses the mesial plane upon the anterior aspect of the trachea. As a general rule it covers the second, third, and fourth tracheal rings, so that only one ring is left exposed between its upper margin and the cricoid cartilage. A branch of the superior thyroid artery runs along the upper margin of the isthmus, whilst upon its anterior surface is placed a plexiform arrangement of small veins. The *inferior thyroid veins* are two in number, and of large size. They are formed by several tributaries which issue from the isthmus and the lateral lobes, and proceed downwards upon the front of the trachea, one upon either side of the mesial plane. As they descend they frequently anastomose, and the branches which pass between them may assume a plexiform arrangement. Sometimes the two inferior thyroid veins unite at a variable point in front of the trachea into one large trunk. Close to the sternum the *innominate artery* will be observed lying upon the trachea, and slightly below the level of the upper border of the bone *the left innominate vein* crosses it. The *thymus body* in children of two years or under is always prolonged upwards for some distance into the neck in front of the trachea. The *thyroidea ima* is an occasional branch of the innominate artery. When present it passes vertically upwards in front of the trachea to the isthmus of the thyroid gland.

The parts which separate the trachea, with the structures in immediate relation to its anterior aspect, from the surface should now be studied. The two anterior jugular veins as they run downwards in the superficial fascia, one upon either side of the mesial plane, have been already noticed; also, the two layers of the deep cervical fascia close to the upper margin of the sternum, and in the interval between these the cross-branch connecting the two anterior jugular veins. Behind the fascial envelope of the neck come the two muscular strata formed by the sterno-hyoid and the sterno-thyroid muscles. The inner margins of the sterno-hyoid muscles are almost contiguous above, and held together by the fascial sheaths which enclose them; below, however, they diverge slightly from each other, so as to expose, close to the sternum, the inner margins of the sterno-thyroid muscles. The sterno-thyroid muscles, in contact with each other below, gradually separate from each other as they ascend. A narrow, lozenge-shaped space is thus left between the inner borders of these muscles. Over this area, the trachea is not covered by any muscular structure. Behind the muscles is the pretracheal layer of fascia.

Surgical Anatomy.—The principal operations which are performed in the middle line of the neck are those of laryngotomy and tracheotomy.

In laryngotomy, an opening is made into the larynx. This can most readily be done in the interval between the thyroid and cricoid cartilages. A vertical mesial incision through the integument is made over this interval. The crico-thyroid membrane is thus exposed, and is divided *transversely* close to the upper margin of the cricoid cartilage. Only the middle portion of the crico-thyroid membrane should be divided, so as to avoid injury to the crico-thyroid muscles.

Tracheotomy is a more serious operation. The opening into the trachea may be made above or below the isthmus of the thyroid body. The *high operation* is preferred by the surgeon. Its advantages are very apparent: here the trachea lies near the surface, and no veins of any importance are met with. The only drawback consists in the small portion of trachea which intervenes between the isthmus and the cricoid cartilage. Still, by dividing the pretracheal fascia transversely below its attachment to the cricoid cartilage, the isthmus can be pushed downwards and the interval between it and the cricoid considerably increased. In certain cases it may be necessary to divide the isthmus, and even to open into the lower part of the larynx by extending the incision through the cricoid cartilage.

The *low operation* is a formidable undertaking. It is true that there is a greater length of tube to be operated upon; but this is situated very deeply, and the surgeon encounters many difficulties before it is reached. If the dissector reflect upon the structures which intervene between this part of the trachea and the surface, he will fully realise this; and he must bear in mind that these difficulties are greatly intensified in the living subject by the engorged state of the veins, and the convulsive movements of the windpipe as the patient struggles for breath. In the child, the thymus body interposes an additional obstacle; and this, combined with the more limited space, the small calibre and great mobility of the trachea, renders the operation, in such cases, a serious responsibility. In the low operation, the trachea must be opened in an upward direction, so as to avoid injury to the innominate artery and left innominate vein, which are placed in front of it at the upper margin of the sternum.

Infra-hyoid Muscles.—These are a series of flat, narrow, band-like muscles which lie upon the trachea, thyroid body, and larynx. They are disposed in two strata—viz., the omo-hyoid and the sterno-hyoid constituting a superficial layer; and the sterno-thyroid and thyro-hyoid a deep layer.

The *omo-hyoid* (musculus omohyoideus), as we have noted, is a two-bellied muscle. The *posterior belly* springs from the upper border of the scapula and the suprascapular ligament. It crosses the posterior triangle of the neck, so as to divide it into an occipital and supraclavicular portion, and finally terminates in the intermediate tendon. This tendon lies under cover of the sterno-mastoid muscle, and is held in position by a strong process of fascia derived from the cervical aponeurosis, and firmly attached below to the sternum and the first costal cartilage. The *anterior belly* emerges from under cover of the anterior border of the sterno-mastoid, and takes an almost vertical course through the anterior triangle. It is inserted into the lower border of the body of the hyoid bone, close to the outer side of the sterno-hyoid. In the anterior triangle of the neck, the anterior belly of the omo-hyoid forms the boundary between the carotid and the muscular subdivisions of this area. Both bellies are supplied by branches from the *ansa hypoglossi*.

The *sterno-hyoid* (musculus sternohyoideus) arises from the posterior aspect of the inner end of the clavicle and the posterior sterno-clavicular ligament. Its origin, however, is very variable; thus, it may be shifted either inwards or outwards. In the former case, it springs from the back of the manubrium sterni and the ligament; in the latter case, from the clavicle alone. It is inserted into the lower border of the body of the hyoid bone, between the mesial plane and the insertion of the omo-hyoid. A short distance above the sternum an oblique fibrous intersection frequently divides it into two portions. The sterno-hyoid is supplied by branches from the *ansa hypoglossi.*

The *sterno-thyroid* (musculus sternothyreoideus) lies under cover of the preceding muscle, and is both broader and shorter. It springs from the posterior aspect of the manubrium sterni and from the cartilage of the first rib. Diverging slightly from its neighbour as it ascends, it is inserted into the oblique line on the outer face of the ala of the thyroid cartilage. An incomplete tendinous intersection may sometimes be noticed interrupting its muscular fibres. The nerve supply of the sterno-thyroid is derived from the *ansa hypoglossi.*

The *thyro-hyoid* (musculus thyreohyoideus) lies on the same plane as the sterno-thyroid; indeed, it may be regarded as its continuation upwards. It takes origin from the oblique line on the thyroid ala, and is inserted into the lower border of the body and a part of the great cornu of the hyoid bone under cover of the sterno-hyoid and omo-hyoid muscles. The thyro-hyoid muscle is supplied by a delicate branch from the *hypoglossal nerve.*

Digastric Muscle (musculus digastricus).—This muscle limits the submaxillary triangle inferiorly, and intervenes between it and the carotid triangle.

The *anterior belly of the digastric* springs from an impression upon the deep aspect of the base of the mandible, close to the symphysis, whilst the *posterior belly* takes origin from the digastric fossa of the temporal bone under cover of the mastoid process. Both bellies converge as they proceed towards the upper border of hyoid bone, where they are joined by a strong round *intermediate tendon.* The posterior belly is the longer of the two, and is fusiform in shape; the anterior belly is shorter and flatter, and descends in a more vertical direction. The intermediate tendon is bound down to the great cornu and the body of the hyoid bone by a strong aponeurotic band. The anterior belly of the digastric is supplied by the *mylo-hyoid nerve*; the posterior belly by a twig from the *facial nerve.*

Stylo-Hyoid Muscle (musculus stylohyoideus).—The stylo-hyoid muscle lies along the upper border of the posterior belly of the digastric. It is a small muscular band which arises from the posterior aspect of the styloid process of the temporal bone not far from its base. It is generally inserted by two slips into the hyoid bone at the point where the great cornu joins the body. The intermediate tendon of the digastric passes forwards between the two slips of insertion of the stylo-hyoid. This muscle receives its nerve of supply from the *facial nerve.*

Hypoglossal Nerve (nervus hypoglossus).—The portion of the hypoglossal nerve which traverses the anterior triangle can be studied at this stage. It appears by emerging from under cover of the posterior belly of the digastric, and immediately curves forwards by hooking round the occipital artery. Near the upper border of the hyoid bone it disappears from the present dissection by passing under cover of the mylo-hyoid muscle. It forms a loop on the side of the neck which lies upon the external carotid and lingual arteries, and finally, above the hyoid bone, upon the hyoglossus muscle. It is crossed by the intermediate tendon of the digastric and the two slips of insertion of the stylo-hyoid.

Two branches will be seen to arise from this portion of the hypoglossal nerve, viz. :—

1. The ramus descendens.
2. The thyro-hyoid.

The *ramus descendens hypoglossi*, as a rule, leaves the hypoglossal nerve at the point where it turns round the occipital artery. It proceeds downwards and inwards so as to cross the common carotid artery very obliquely. Reaching the upper border of the anterior belly of the omo-hyoid, it ends by joining a slender branch which advances towards it from the second and third cervical nerves. This nerve is called the *ramus cervicalis descendens*, and by its union with the ramus descendens hypoglossi a nerve loop is formed in front of the common carotid artery, which is called the *ansa hypoglossi.*

From the convexity of this loop branches are given off which supply both bellies of the omo-hyoid, the sterno-hyoid, and sterno-thyroid muscles.

The branches for the anterior belly of the omo-hyoid may proceed from the ramus descendens hypoglossi before it reaches the ramus cervicalis descendens. The filament for the posterior belly runs downwards and backwards along the lower border of the intermediate tendon, and between the two laminæ of the fascial sheath which retains the tendon in position. The branch for the sterno-hyoid and sterno-thyroid muscles is a nerve which breaks up along their outer margins into a number of twigs for their supply. One small filament may sometimes be traced into the thorax, where it communicates with the phrenic and cardiac nerves.

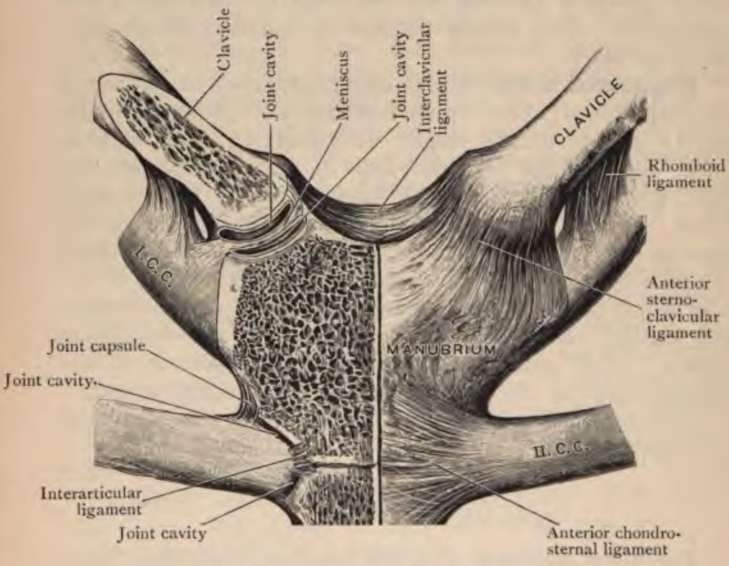

Clavicle
Joint cavity
Meniscus
Joint cavity
Interclavicular ligament
CLAVICLE
Rhomboid ligament
I.C.C.
Anterior sterno-clavicular ligament
Joint capsule
Joint cavity
MANUBRIUM
II. C.C.
Interarticular ligament
Joint cavity
Anterior chondro-sternal ligament

FIG. 82.—Sterno-clavicular and Costo-sternal Joints.

The *thyro-hyoid nerve* is a slender twig which comes off from the hypoglossal as it approaches the hyoid bone. It supplies the thyro-hyoid muscle.

Sterno-Clavicular Articulation (articulatio sterno-clavicularis).—The dissector must now examine the sterno-clavicular joint, as the next step consists in the disarticulation of the clavicle and the reflection of the clavicular origin of the sterno-mastoid muscle.

The structures which hold the two bones in position at this joint are the following:—

Ligaments proper.	Anterior sterno-clavicular. Posterior sterno-clavicular.
Accessory ligaments.	Interclavicular. Costo-clavicular or rhomboid.
Interarticular fibro-cartilage.	

Dissection.—To expose these ligaments the origin of the pectoralis major from the clavicle and the manubrium sterni must be removed. The sternal origin of the sterno-mastoid is also, to a certain extent, in the way, but it is not advisable to divide this.

Sterno-Clavicular Ligaments.—These are placed one in front and the other behind the joint, but they are not isolated sharply defined bands. Above, they are united by their margins with the interclavicular ligament, whilst below they run into each other so as to constitute in this manner a capsule for the joint (capsula articularis). The *anterior sterno-clavicular ligament* springs from the front of the inner end of the clavicle, and proceeds obliquely downwards and inwards to gain attachment to the anterior aspect of the manubrium sterni. The *posterior sterno-clavicular ligament* has a corresponding position, and presents similar attachments on the posterior aspect of the joint.

These ligaments limit the backward and forward movements of the inner end of the clavicle, upon the sternal facet.

Interclavicular Ligament (ligamentum interclaviculare).—This is a strong band which connects the inner ends of the two clavicles. It is firmly fixed to the upper edge of each bone, and as it passes across the middle line it dips into the notch on the upper margin of the sternum, and is attached to it also.

Rhomboid Ligament (ligamentum costoclaviculare).—The costoclavicular or rhomboid ligament is composed of short oblique fibres. It is placed behind the subclavius muscle, the remains of which must therefore be removed to expose its anterior surface; at the same time the clavicle must be tilted upwards as high as possible. The rhomboid ligament is attached by its lower border to the cartilage of the first rib. From this it is carried obliquely upwards, backwards, and outwards, and is fixed by its upper border to a rough depression upon the under surface of the inner end of the clavicle.

The rhomboid ligament plays an important part in the mechanism of the joint, and adds greatly to its security. It checks excessive elevation of the shoulder, and restrains, within certain limits, both forward and backward movement of the clavicle.

Dissection.—The interarticular fibro-cartilage is the most important of all the agents concerned in maintaining the apposition of the inner end of the clavicle with the sternum. To obtain a view of this structure, the joint must be opened into; indeed, it is well to remove as far as possible all the ligaments. Begin by dividing the rhomboid ligament. To effect this the clavicle must be raised and the knife carried inwards between its inner end and the first costal cartilage. Next remove the interclavicular and anterior and posterior sterno-clavicular ligaments. It is difficult to get at the posterior sterno-clavicular ligament in the present condition of parts, but with a little care the sterno-hyoid muscle may be detached from its surface, and its fibres divided. The clavicle should now be forcibly pulled outwards, when the interarticular fibro-cartilage will become apparent.

Interarticular Fibro-Cartilage (discus articularis).—This is a nearly circular meniscus or plate interposed between the inner end of the clavicle and the sternal facet. Its surfaces are accurately moulded upon both. As a general rule it is thicker around its circumference than in the centre, where it is occasionally perforated. By its circumference it is closely attached to the capsule of the joint both in front and behind. *Above*, it is firmly fixed to the upper edge of the inner end of the clavicle; *below*, its margin is thinned and passes outwards under the clavicle to gain attachment to the inner end of the cartilage of the first rib.

The part which the interarticular meniscus plays in the mechanism of the joint is very apparent. Its function is twofold: (1) it acts as a cushion, and thus lessens the shock of blows received upon the shoulder; (2) it acts as a bond of union, and prevents the clavicle from being driven upwards upon the top of the sternum when force is applied to its outer end.

Synovial Membranes.—The sterno-clavicular joint is provided with two synovial membranes, placed one upon either side of the interarticular fibro-cartilage. These are quite distinct from each other, except in cases where the fibro-cartilage is deficient in its centre. In the latter case the two synovial cavities communicate.

Dissection.—Complete the disarticulation of the clavicle by dividing the attachment of the fibro-cartilage to the first costal arch. By this step the meniscus is removed with the clavicle, and can therefore be more fully examined. Further, the clavicular portion of the sterno-mastoid can now be thrown forward, and the parts under cover of this muscle dissected. The sternal origin of the sterno-mastoid should not be interfered with until the subclavian and carotid vessels have been studied.

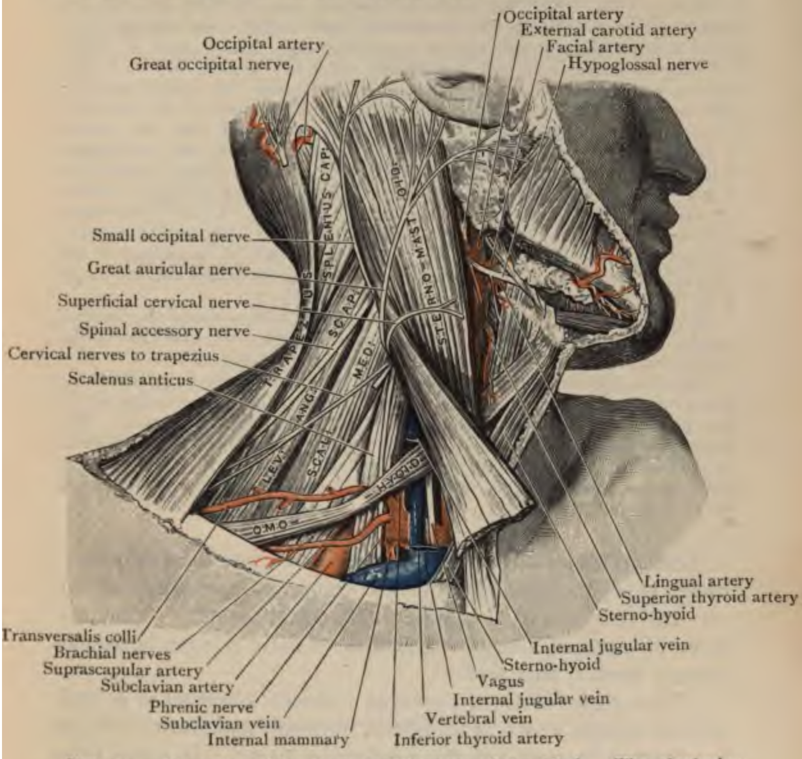

Occipital artery
External carotid artery
Facial artery
Hypoglossal nerve
Occipital artery
Great occipital nerve
SPLENIUS CAP.
OMO.
STERNO-MAST.
Small occipital nerve
Great auricular nerve
Superficial cervical nerve
Spinal accessory nerve
Cervical nerves to trapezius
Scalenus anticus
TRAPEZIUS
SCAP.
MED.
ANG.
LEV.
SCAL.
HYOID
OMO
Lingual artery
Superior thyroid artery
Sterno-hyoid
Transversalis colli
Brachial nerves
Suprascapular artery
Subclavian artery
Phrenic nerve
Subclavian vein
Internal mammary
Internal jugular vein
Sterno-hyoid
Vagus
Internal jugular vein
Vertebral vein
Inferior thyroid artery

FIG. 83.—Dissection of the Posterior Triangle of the Neck. The clavicular portion of the sterno-mastoid has been detached from the clavicle and thrown forwards.

Certain structures at the root of the neck must now be displayed. These are :—

1. The scalene muscles.
2. The phrenic nerve.
3. The subclavian vessels and their branches.
4. The cervical pleura.
5. The thoracic duct on the left side, and the right lymphatic duct on the right side.
6. The lower part of the internal jugular vein.
7. The vagus nerve.
8. The lower part of the common carotid artery.
9. The lower part of the cervical sympathetic.

As the dissection is proceeded with, a large number of important structures will be observed grouped in relation to the scalenus anticus muscle. Thus it is crossed *in front* and from below upwards by—(1) the subclavian vein, which lies upon its insertion into the first rib; (2) the suprascapular artery; (3) the transversalis colli artery; and (4) the omohyoid muscle, with the nerve to its posterior belly. Under cover of these, the phrenic nerve is carried downwards upon the anterior aspect of the muscle, whilst the thoracic duct on the left side, and the right lymphatic duct on the right side, lie for a short distance in front of the scalenus anticus near its inner margin. Both of these ducts open into the venous system at the angle of union between the internal jugular and subclavian veins. *Behind* the scalenus anticus, the cervical pleura bulges upwards for a short distance into the neck, and the subclavian artery and the brachial nerves are also in relation to its posterior surface. Close to its *inner margin* are the thyroid axis, the vertebral artery and vein, and, somewhat overlapping it, the large internal jugular vein; whilst ascending in the interval between the scalenus anticus and the rectus capitis anticus major is the small ascending cervical artery.

Between the scalenus anticus and the trachea will be found the internal jugular vein, the vagus nerve, common carotid artery, the first part of the subclavian artery with its branches, and the sympathetic cord.

This is a tedious dissection, on account of the numerous twigs which are given off by the sympathetic. Certain of these descend in relation to the first part of the subclavian artery, and must be carefully preserved. The middle cervical ganglion, as a general rule, rests upon the inferior thyroid artery, whilst the lowest ganglion in the neck is placed in the depression between the transverse process of the last cervical vertebra and the neck of the first rib.

Scalene Muscles.—These muscles constitute the fleshy mass which is seen extending from the transverse processes of the cervical vertebræ to the upper two costal arches. They are three in number, and are named, from their relative positions, *anticus*, *medius*, and *posticus*.

The *scalenus anticus* (musculus scalenus anterior) is a well-defined muscle which is separated from the scalenus medius by the brachial nerves and the subclavian artery. It arises from the anterior tubercles of the transverse processes of four cervical vertebræ—viz., the third, fourth, fifth, and sixth,—and, tapering somewhat as it descends, is inserted into the scalene tubercle on the inner margin of the first rib, and also into the upper surface of the same bone between the two subclavian grooves.

The *scalenus medius* (musculus scalenus medius) is a more powerful muscle than the preceding. It springs from the posterior tubercles of all the cervical transverse processes (with the exception, in some cases, of the first), and it is inserted into a rough oval impression which marks the upper surface of the first rib between the tubercle and the groove for the subclavian artery.

The *scalenus posticus* (musculus scalenus posterior) is generally inseparable at its origin from the scalenus medius. It is the smallest of the three, and springs by two or three slips from the transverse processes of a corresponding number of the lower cervical vertebræ in common with the scalenus medius. It is inserted into the upper border of the second rib, immediately in front of the insertion of the levator costæ.

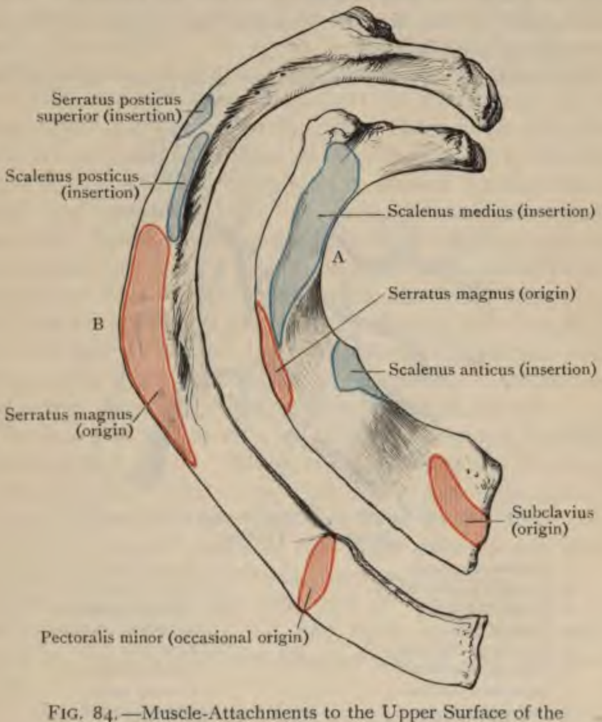

Serratus posticus superior (insertion)
Scalenus posticus (insertion)
Scalenus medius (insertion)
A
Serratus magnus (origin)
B
Scalenus anticus (insertion)
Serratus magnus (origin)
Subclavius (origin)
Pectoralis minor (occasional origin)

FIG. 84.—Muscle-Attachments to the Upper Surface of the First Rib, and the Outer Surface of the Second Rib.
A, First rib; B, Second rib.

The scalene muscles are supplied by twigs from the *lower four cervical nerves.*

Subclavian Artery (arteria subclavia).—The subclavian artery is the first subdivision of the great vessel which carries blood for the supply of the upper limb. It arises differently on the two sides of the body. On the *right side* it takes origin behind the sterno-clavicular articulation by the bifurcation of the innominate artery. On the *left side* it springs, within the cavity of the thorax, from the aortic arch. In both cases it takes an arched course outwards across the root of the neck, behind the scalenus anticus muscle and in front of the cervical dome of pleura, a short distance below its summit. At the outer border of the first rib it enters the axilla and receives the name of axillary artery.

The relations of the subclavian artery are so numerous, and so varied in character, at different parts of its extent, that it is found necessary to subdivide it into three portions. The *first part* extends from the origin of the vessel to the inner margin of the scalenus anticus; the *second portion* lies behind this muscle; whilst the *third part* extends from the outer border of the scalenus anticus to the outer border of the first rib.

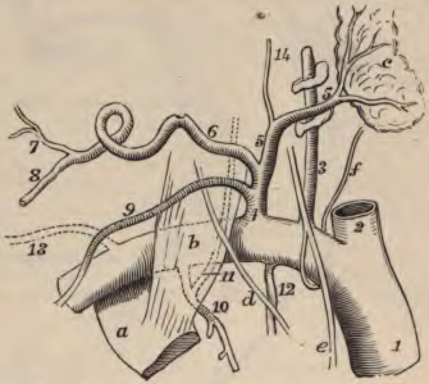


FIG. 85.—Diagram of the Subclavian Artery and its Branches. (Turner.)

1. Innominate artery.
2. Common carotid artery.
3. Vertebral artery.
4. Thyroid axis.
5. Inferior thyroid artery.
6. Transversalis colli.
7. Superficial cervical.
8. Posterior scapular.
9. Suprascapular.
10. Superior intercostal.
11. Deep cervical.
12. Internal mammary.
13. Posterior scapular.
14. Ascending cervical.

a. First rib.
b. Scalenus anticus.
c. Thyroid body.
d. Phrenic nerve.
e. Vagus nerve.
f. Recurrent laryngeal.

First part.—Owing to the difference of origin, the relations presented by the first portion of the subclavian artery are not the same on the two sides of the body. Let us examine, in the first instance, the vessel of the right side, and then compare it with that of the left side. The first part of the *right subclavian* extends obliquely upwards and outwards, and at its termination, at the inner margin of the scalenus anticus, it has reached a point above the level of the clavicle. It is placed very deeply. *In front*, it is covered by the skin, superficial fascia, platysma, deep fascia, and three muscular strata—viz., the clavicular origin of the sterno-mastoid, the sterno-hyoid, and the sterno-thyroid. Three veins and some nerves are also placed in front of it. Thus, close to the inner margin of the scalenus anticus, it is crossed by the internal jugular and vertebral veins, as these proceed from above downwards, whilst the anterior jugular vein, as it passes outwards under cover of the sterno-mastoid, is separated from it by the sterno-hyoid and sterno-thyroid muscles. The nerves which cross it are the vagus, with the cardiac branches of the vagus and sympathetic as they run towards the thorax, and a loop from the sympathetic (annulus Vieusseni). As the vagus nerve leaves the artery it gives off its recurrent branch.

The first part of the subclavian artery presents important relations to the pleura. The cervical dome of this membrane bulges upwards behind it so that the vessel rests upon its anterior surface a short distance from its summit. The recurrent laryngeal branch of the vagus nerve hooks round it, and is thus related to it both below and behind.

Immediately below the first part of the subclavian, and upon a more anterior plane, the right innominate vein is formed by the union of the internal jugular and subclavian trunks.

On the *left side*, the first part of the subclavian ascends almost vertically from its origin from the aortic arch, and, reaching the root of the neck, it curves outwards upon the pleura to gain the inner margin of the scalenus anticus. It is only with that portion of the vessel which lies in the root of the neck that we are concerned at present. Its relations are somewhat different from those on the right side. The same fascial and muscular layers, and the same nerves and veins, lie in front of it. Owing to its different direction, however, the latter are placed more or less parallel to it. Three additional relations are established — viz., (1) the phrenic nerve, which descends in front of it; (2) the left innominate vein, which crosses it; and (3) the thoracic duct, which first passes upwards in relation to its inner or right side, and then arches over it to reach the angle of junction between the subclavian and internal jugular veins.

The recurrent laryngeal nerve, which on this side hooks round the arch of the aorta, lies to the inner side of the subclavian artery.

Second part.—The second portion of the subclavian artery forms the highest part or summit of the arch. The average height to which the subclavian artery rises in the neck varies from half an inch to an inch above the level of the clavicle. In some cases, indeed, it may reach the level of the lower part of the lateral lobe of the thyroid body.

In this part of its course the vessel is not so deeply placed. *In front*, it is covered by—(1) skin; (2) superficial fascia and platysma; (3) deep fascia; (4) clavicular head of the sterno-mastoid; (5) scalenus anticus. The phrenic nerve on the right side is also an anterior relation. It passes downwards in front of the vessel, but separated from it by the inner margin of the scalenus anticus. *Behind and below*, the vessel is in contact with the pleura. The subclavian vein lies at a lower level and in front of the artery. It is separated from the artery by the scalenus anticus, which intervenes between the two vessels.

The *third part* of the subclavian artery has already been examined (p. 192).

Branches of the Subclavian Artery.—Four branches spring from the subclavian trunk (Figs. 83 and 85). In this respect, however, the vessel is subject to considerable variation. They all take origin, as a general rule, close together; three proceeding from the first part of the artery close to the scalenus anticus, and one from the second part. They are—

From the *first part*.	1. Vertebral.	
	2. Thyroid axis.	Inferior thyroid. Transversalis colli. Suprascapular.
	3. Internal mammary.	
From the *second part*.	Superior intercostal.	Superior intercostal proper. Deep cervical.

In a great number of cases, a branch of considerable size will be observed springing from the third part of the subclavian artery. This, in all probability, will be the posterior scapular artery arising directly from the subclavian. It is so common an occurrence, that the dissector must always be prepared to meet it.

Vertebral Artery (arteria vertebralis).—This is the first branch which is given off by the subclavian. It springs from the posterior aspect of the trunk about a quarter of an inch from the inner margin of the scalenus anticus on the right side, and from the point where the vessel reaches the root of the neck on the left side. Only a small portion of its extent is seen in the present dissection. It proceeds upwards in the interval between the longus colli and the scalenus anticus muscles, and disappears by entering the foramen transversarium of the transverse process of the sixth cervical vertebra. It is placed very deeply, and is covered in front by its companion vein and the internal jugular vein. Numerous large sympathetic twigs accompany it.

The vertebral artery on the *left side* is crossed by the thoracic duct.

The *vertebral vein* will be noticed issuing from the aperture in the transverse process of the sixth cervical vertebra. It passes downwards in front of its companion artery, and behind the internal jugular vein, to open into the posterior aspect of the commencement of the corresponding innominate vein. Near its termination it crosses the subclavian artery. It receives the *deep cervical* and the *anterior vertebral veins.*

Thyroid Axis (truncus thyreocervicalis).—This is a short wide trunk, which arises from the front of the subclavian artery, close to the inner margin of the scalenus anticus, and under cover of the internal jugular vein. It lies between the phrenic and pneumogastric nerves, and almost immediately breaks up into its three terminal branches—viz., the inferior thyroid, the suprascapular, and the transversalis colli.

Inferior Thyroid Artery (arteria thyreoidea inferior).—This vessel takes a sinuous course to reach the thyroid body. At first, it ascends for a short distance upon the vertebral artery, and under cover of the internal jugular vein; then, at the level of the cricoid cartilage, it turns suddenly downwards and inwards, and passes behind the sympathetic, vagus, and the common carotid artery; lastly, it bends upwards, and ends in branches at the base of the lateral lobe of the thyroid body.

The following branches will be noticed arising from the inferior thyroid artery:—

1. Ascending cervical.
2. Inferior laryngeal.
3. Tracheal.
4. Œsophageal.
5. Thyroid.
6. Muscular.

The *ascending cervical artery* (arteria cervicalis ascendens) is a small but very constant vessel, which runs upwards in the interval between the scalenus anticus and rectus capitis anticus major, and dispenses branches to the muscles in front of the vertebral column. Other twigs from the ascending cervical, termed *spinal branches*, enter the spinal canal upon the spinal nerves, and anastomose with branches from the vertebral artery. The ultimate distribution of the spinal branches has already been noticed (p. 158).

The *inferior laryngeal artery* (arteria laryngea inferior) is a small vessel which accompanies the recurrent laryngeal nerve to the larynx. The *tracheal* (rami tracheales) and *œsophageal* (rami œsophagei) *branches* in like manner supply the trachea and gullet. They are of small size, and anastomose with the bronchial and œsophageal branches of the thoracic aorta. The *thyroid* or *terminal branches* (rami glandulares) are usually two in number. One ascends upon the posterior aspect of the lateral lobe of the thyroid body, whilst the other is given to its base or lower end. They inosculate with the corresponding vessels of the opposite side, and also with the branches of the superior thyroid artery. The *muscular branches* are a series of irregular twigs given to the various muscles in the neighbourhood.

The *inferior thyroid vein* does not run in company with the artery of the same name. It is a large vessel which comes from the lateral lobe of the thyroid body, and descends upon the trachea under cover of the sterno-thyroid muscle. The veins of both sides enter the thorax, and frequently unite to form a short common stem, which opens into the innominate trunk. In other cases, however, the right vein will be observed to open separately into the angle of union between the two innominate veins. Both veins receive, as they proceed downwards, tributaries from larynx, trachea, and œsophagus.

The *anterior vertebral vein* accompanies the ascending cervical artery, and opens into the vertebral vein as it issues from the foramen transversarium of the sixth cervical vertebra.

Suprascapular and Transversalis Colli Arteries.—Both of these arteries have already been examined in the greater part of their course (p. 193). After taking origin from the thyroid axis, they both pass outwards upon the scalenus anticus muscle, and under cover of the clavicular head of the sterno-mastoid. The *suprascapular* (arteria transversa scapulæ) crosses the anterior scalene muscle close to its insertion, immediately above the subclavian vein; the *transversalis colli* (arteria transversa colli) is placed at a slightly higher level. Both vessels cross in front of the phrenic nerve.

The *suprascapular* and *transversalis colli veins* have already been seen joining the subclavian or the external jugular vein.

Internal Mammary Artery (arteria mammaria interna).—The internal mammary springs from the lower aspect of the subclavian opposite the thyroid axis. It proceeds downwards upon the anterior surface of the pleura and behind the inner end of the clavicle, to reach the thoracic cavity. In the cervical part of its course it will be observed to pass behind the subclavian vein, and to be crossed from without inwards by the phrenic nerve. In the neck, the internal mammary artery is not accompanied by a companion vein.

Superior Intercostal Artery (truncus costocervicalis).—This branch takes origin from the posterior aspect of the second portion of the subclavian artery, close to the inner border of the scalenus anticus. On the left side, however, it, as a rule, proceeds from the first part of the parent trunk. To bring it into view, the subclavian artery must be dislodged from its position. It is a short trunk which passes upwards and backwards over the pleura to the neck of the first rib, where it divides into the *deep cervical artery* and the *superior intercostal artery proper.*

The *deep cervical artery* (arteria cervicalis profunda) passes backwards, and disappears from view between the transverse process of the seventh cervical vertebra and the neck of the first rib. It has been already noticed in the dissection of the back of the neck (p. 148).

The *superior intercostal artery* (arteria intercostalis suprema) turns downwards in front of the neck of the first rib, between the last dorsal nerve and the first thoracic ganglion of the sympathetic, and ends in the thorax by giving branches to the upper two intercostal spaces.

The *deep cervical vein* is a large vessel. It joins the vertebral vein.

Subclavian Vein (vena subclavia).—The subclavian vein is the continuation of the axillary vein into the root of the neck. It begins, therefore, at the outer border of the first rib, and arches inwards in front of the scalenus anticus muscle close to its insertion. At the inner margin of this muscle, and behind the inner end of the clavicle, it joins the internal jugular to form the innominate vein. In connexion with the subclavian vein, note: (1) that the arch which it forms is not so pronounced as in the case of the corresponding artery; (2) that throughout its whole course it lies at a lower level, and upon a plane anterior to the artery; and (3) that it is separated from the artery by the scalenus anticus and the phrenic nerve.

The sheath of the subclavian vein is attached to the posterior surface of the costocoracoid membrane. This is a relation of some practical importance. A forward movement of the clavicle drags upon the vein, and in cases where the vessel is wounded there is always a danger of air being sucked into the vein by such a movement. A fatal result ensues upon the entrance of air into the heart.

The *tributaries* of the subclavian vein are (1) the external jugular vein, and (2) in some cases the anterior jugular vein. These join it at the outer margin of the scalenus anticus muscle.

Thoracic and Right Lymphatic Ducts.—The *thoracic duct* (ductus thoracicus) is the vessel by means of which the lymph and chyle, derived from by far the greater part of the body, are poured into the venous system on the left side (see p. 87). Its terminal or cervical portion is displayed in the present dissection. It is a small delicate vessel, frequently mistaken for a vein, which enters the root of the neck upon the left side of the œsophagus. It is here, therefore, that it should be sought. When it reaches the level of the seventh, or perhaps the sixth cervical vertebra, it changes its course and arches outwards and forwards, and then downwards upon the apex of the pleura, to gain the outer margin of the internal jugular vein at its angle of union with the subclavian, and into this it opens. As the thoracic duct courses outwards, it is placed at a higher level than the subclavian artery, and passes behind the internal jugular vein. Further, as it approaches the point at which it ends, it crosses the first part of the subclavian artery.

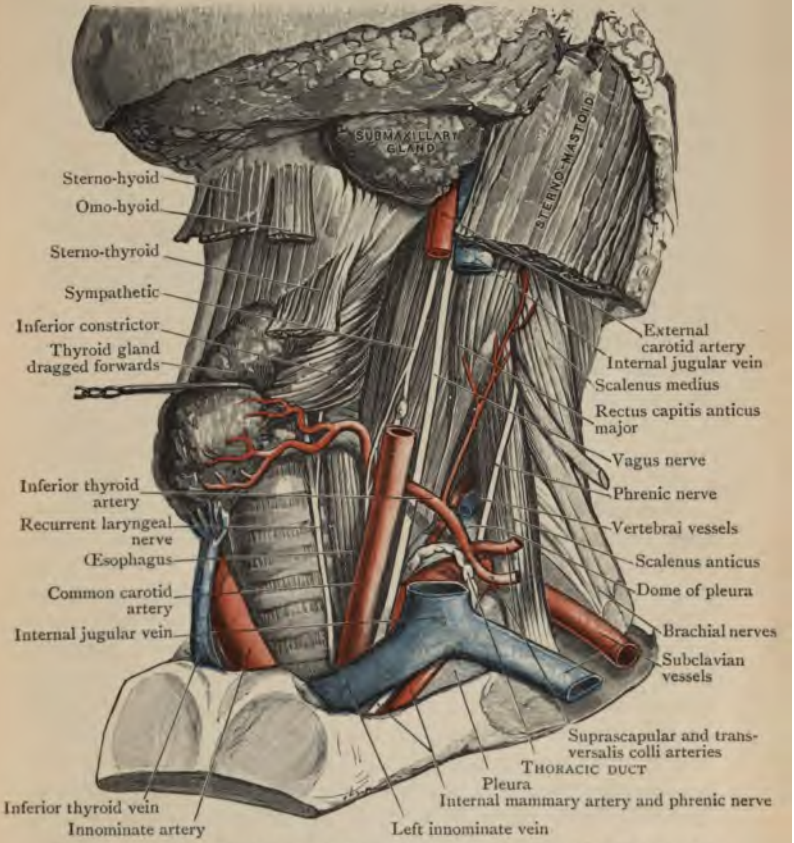

SUBMAXILLARY GLAND
STERNO-MASTOID
Sterno-hyoid
Omo-hyoid
Sterno-thyroid
Sympathetic
Inferior constrictor
Thyroid gland dragged forwards
Inferior thyroid artery
Recurrent laryngeal nerve
Œsophagus
Common carotid artery
Internal jugular vein
Inferior thyroid vein
Innominate artery
External carotid artery
Internal jugular vein
Scalenus medius
Rectus capitis anticus major
Vagus nerve
Phrenic nerve
Vertebral vessels
Scalenus anticus
Dome of pleura
Brachial nerves
Subclavian vessels
Suprascapular and transversalis colli arteries
THORACIC DUCT
Pleura
Internal mammary artery and phrenic nerve
Left innominate vein

FIG. 86.—Deep Dissection of the Root of the Neck on the Left Side to show the Dome of the Pleura and the relations of the Terminal Part of the Thoracic Duct. The sterno-mastoid and the depressors of the hyoid and larynx have been removed.

A valve composed of two segments guards its orifice into the jugular vein. This allows its contents to flow freely into the vein, but acts as a barrier to the passage of venous blood into the duct.

The *right lymphatic duct* (ductus lymphaticus dexter) is the corresponding vessel upon the right side. It is a very insignificant duct, and draws its supply of lymph from a much more restricted field. It is formed by the union of the lymphatic vessels from the right upper limb with the right common jugular lymphatic trunk. It likewise receives the efferent lymphatic vessels from the intercostal glands which lie in the upper interspaces of the right side and from the thoracic visceral glands of the right side. It constitutes, therefore, the main lymphatic drain for the following districts: (1) right upper limb; (2) right side of the head and neck; (3) upper part of right thoracic wall; (4) right side of diaphragm and upper surface of liver; (5) thoracic viscera on right side of mesial plane, viz., right side of heart and pericardium and the right lung and pleura.

In length the right lymphatic duct rarely measures more than half an inch. It will be found at the inner margin of the scalenus anticus opening into the angle of union between the internal jugular and subclavian veins of the right side. As in the case of the thoracic duct, its orifice is guarded by a double valve.

Cervical Pleura.—The pleural sac of each side, with the apex of the corresponding lung, projects upwards into the root of the neck, and the dissector should now examine the height to which it rises, and the connections which it establishes. Its height with reference to the first pair of costal arches varies in different subjects. In some cases it extends up for two inches above the sternal end of the first rib; in others for not more than one inch. These differences depend on the degree of obliquity of the thoracic inlet. Posteriorly, and in all cases, the apex of the pleura will be found to correspond in level with the neck of the first rib. It forms a dome-like roof for each side of the thoracic cavity, and is strengthened by a fascial expansion (frequently termed *Sibson's fascia*), which, covers it completely, and is attached on the one hand to the transverse process of the seventh cervical vertebra and on the other to the inner margin of the first rib. Observe, further, that the cervical pleura is supported above by the scalene muscles, under cover of which it ascends into the neck, and that the subclavian artery arches outwards upon its anterior surface near its apex.

Cervical Plexus (plexus cervicalis)—Fig. 87.—This plexus is formed by the anterior primary divisions of the upper four cervical nerves. These nerves are much smaller than the lower cervical nerves which form the brachial plexus, and they have only a short course to run as independent trunks. With the exception of the first, each divides into an ascending and a descending branch; and these joining with each other, constitute the plexus, which, therefore, consists of three loops.

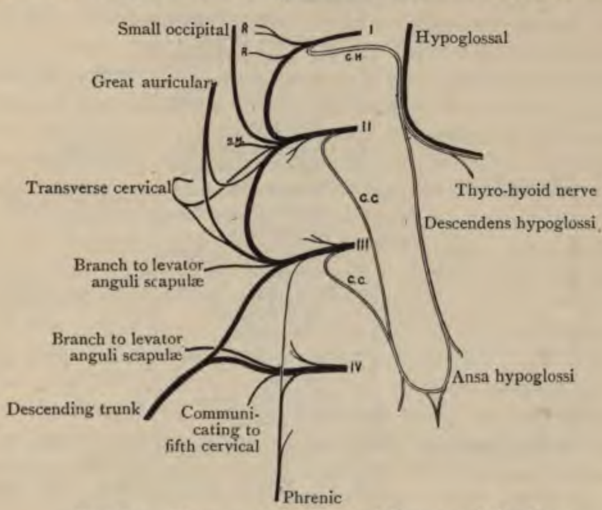

Small occipital
R
R
I
Hypoglossal
C H
Great auricular
S.M.
II
Transverse cervical
C.C
Thyro-hyoid nerve
Descendens hypoglossi
III
Branch to levator anguli scapulæ
C.C
Branch to levator anguli scapulæ
IV
Ansa hypoglossi
Descending trunk
Communicating to fifth cervical
Phrenic

FIG. 87.—Diagram of the Cervical Plexus and the Ansa Hypoglossi.

I, II, III, IV.—Anterior primary divisions of the upper four cervical nerves.

R. Branches to recti muscles.
S.M. Branches to the sterno-mastoid.
C.C. Rami communicantes hypoglossi.
C.H. Communicating branch to hypoglossal.

This diagram shows that the descendens hypoglossi, the branch to the thyro-hyoid, and in all probability the branches to the genio-hyoid, are composed of fibres given to the hypoglossal by the communicating twigs it receives from the first cervical nerve.

The descending branch of the fourth nerve, which is very small, proceeds downwards to unite with the fifth nerve, and thus establishes a connexion with the brachial plexus.

The cervical plexus thus formed has very definite relations. It lies under cover of the upper part of the sterno-mastoid and upon the scalenus medius and the levator anguli scapulæ muscles.

Its branches are very numerous, and may be classified in the following manner:—

Superficial or Cutaneous.	Ascending.	Small occipital.	From 2nd.
		Great auricular.	From 2nd & 3rd.
	Transverse.	Superficial cervical.	
	Descending.	Clavicular. Sternal. Acromial.	From 3rd & 4th.
Deep.	Muscular.	1. To rectus capitis anticus major. 2. To rectus capitis anticus minor. 3. To rectus capitis lateralis.	From 1st & 2nd.
		4. To sterno-mastoid.	From 2nd.
		5. Ramus cervicalis descendens (rami communicantes hypoglossi).	From 2nd & 3rd.
		6. To levator anguli scapulæ. 7. To scalenus medius and posticus. 8. To trapezius.	From 3rd & 4th.
		9. Phrenic to diaphragm.	From 3rd, 4th, & 5th.
	Communicating.	1. To hypoglossal. 2. To vagus.	From 1st.
		3. From sympathetic.	To 1st, 2nd, 3rd, & 4th.
		4. To spinal accessory.	From 2nd, 3rd, & 4th.

The *superficial branches* have already been examined; but now that the plexus is fully dissected, the student should again study their mode of origin.

Muscular Branches.—The *anterior recti muscles* and the *rectus lateralis* receive twigs from the first loop of the plexus; but as this is placed very high up in the neck, these branches can only be satisfactorily displayed in the deep dissection of the neck. The *sterno-mastoid muscle* draws one or more twigs from the second cervical nerve, and by means of these a communication is effected with the spinal accessory nerve, which pierces, and at the same time supplies filaments to the muscle. The *levator anguli scapulæ* always receives two or three branches from the third and fourth nerves, whilst the *scalenus medius* and *scalenus posticus* obtain their nerve-supply from the same nerve trunks before these have entered the plexus. The branches to the *trapezius* come off in common with the trunk which divides into the descending superficial nerves, and are therefore derived from the third and fourth nerves. Upon the under surface of the trapezius, these branches unite with the spinal accessory, and form the *sub-trapezial plexus.*

The *ramus cervicalis descendens* is formed by the union of two long slender roots (rami communicantes hypoglossi) which spring from the second and third nerves respectively. It proceeds downwards and inwards under cover of the sterno-mastoid, and either behind or in front of the internal jugular vein, to join the ramus descendens hypoglossi and form the ansa hypoglossi. In some cases the two roots of the descendens cervicalis remain separate throughout all their course.

The *phrenic nerve* is the most important branch given off by the cervical plexus. It springs from the fourth cervical nerve, and as a rule obtains also a root from the fifth or the third cervical nerve, or perhaps from both. If the root from the fifth nerve fails, the phrenic will in all probability be found to receive lower down a twig from the nerve to the subclavius. The course which the phrenic pursues in the neck is so definite, that there should never be any difficulty in recognising this nerve. It descends, inclining at the same time inwards, in front of the scalenus anticus, and leaves the neck to enter the thorax by passing under cover of the subclavian vein, and crossing the internal mammary artery from without inwards. As it proceeds downwards on the scalenus anticus, it passes behind the omo-hyoid, the transversalis colli artery, the suprascapular artery, and on the left side the thoracic duct.

The phrenic nerve gives off no branches in the neck, but before it enters the thorax it is usually joined by a small sympathetic twig.

Communicating Branches.—(1) At the base of the skull, the first loop of the cervical plexus is brought into close connexion, by means of connecting twigs, with the *vagus* and *hypoglossal nerves.* These cannot be displayed at present, but will be examined in a subsequent dissection.

The fibres which enter the hypoglossal nerve from the first cervical nerve proceed downwards in its trunk and come off as the descendens hypoglossi. The ansa hypoglossi is thus in all probability, composed entirely of fibres derived from the 1st, 2nd, and 3rd cervical nerves. It is also believed that the branches which the hypoglossal nerve gives to the thyro-hyoid muscle and the genio-hyoid muscle likewise come from the 1st cervical nerve.

(2) Each of the four cervical nerves which form the plexus is connected by means of one or more grey rami communicantes with the superior cervical ganglion of the sympathetic. (3) Communications are effected indirectly in two places by the second, third, and fourth nerves with the spinal accessory, viz., in the substance of the sterno-mastoid by the twig from the second nerve to this muscle, and again on the under surface of the trapezius by the branches which go to this muscle from the third and fourth nerves.

Common Carotid Artery (arteria carotis communis).—The common carotid is the great artery of supply to the head and the neck. Its origin is different on the two sides of the body. On the *right side*, it springs with the subclavian from the innominate artery behind the upper part of the sterno-clavicular articulation; on the *left side*, it arises within the thorax, from the aortic arch. In both cases the common carotid ends opposite the lower border of the third cervical vertebra, or at a level corresponding to the upper border of the thyroid cartilage by dividing into the external and internal carotid branches. The point at which this subdivision takes place is subject to a considerable amount of variation within certain limits, and it has been noticed that in short-necked individuals the common carotid artery is relatively longer than in long-necked people. The course which the common carotid arteries pursue in the neck, and the relations which they exhibit, are so much alike on the two sides that one description will suffice for both.

The course of the common carotid is slightly oblique, and may be marked on the surface by drawing a line from the sterno-clavicular articulation to a point midway between the angle of the lower jaw and the mastoid process. At the root of the neck the two vessels are close together, the trachea and œsophagus alone intervening; but as they proceed upwards they diverge slightly from each other, and where they end they are separated by the entire width of the thyroid cartilage and the pharynx.

Together with the internal jugular vein, the pneumogastric nerve, and the descendens hypoglossi nerve, the vessel is enveloped by a strongly marked sheath derived from the cervical fascia. This has been removed, but its constitution, and the relation which its contents bear to each other within it, have been already observed (pp. 186, 201, 202).

The common carotid artery is very differently circumstanced in regard to the surface in its lower and upper parts. Opposite the cricoid cartilage it is crossed by the anterior belly of the omo-hyoid, and below this it is placed very deeply, being covered by the integument, platysma, and deep fascia, and by three muscular strata, viz., the sterno-mastoid, the sterno-hyoid, and the sterno-thyroid.

Above the level of the omo-hyoid muscle it lies within the limits of the carotid triangle, and is therefore placed nearer the surface. Here it is merely overlapped by the anterior margin of the sterno-mastoid muscle, and covered by the platysma, fasciæ, and integument. The vessels and nerves in relation to its anterior surface are:—

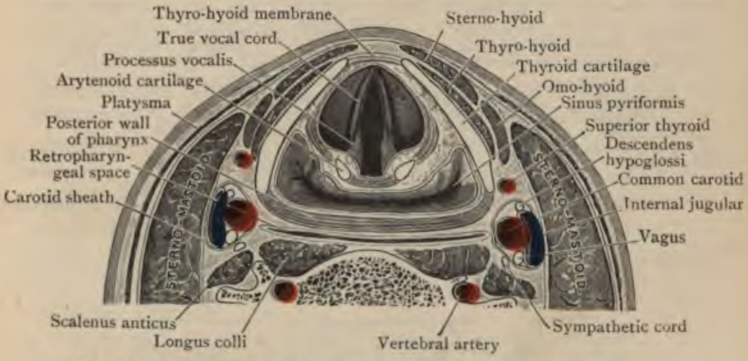

Thyro-hyoid membrane
True vocal cord
Processus vocalis
Arytenoid cartilage
Platysma
Posterior wall of pharynx
Retropharyngeal space
Carotid sheath
STERNO-MASTOID
Sterno-hyoid
Thyro-hyoid
Thyroid cartilage
Omo-hyoid
Sinus pyriformis
Superior thyroid
Descendens hypoglossi
Common carotid
Internal jugular
Vagus
STERNO-MASTOID
Scalenus anticus
Longus colli
Vertebral artery
Sympathetic cord

FIG. 88.—Transverse section through the Neck at the level of upper part of Thyroid Cartilage.

1. Superior thyroid vein.
2. Middle thyroid vein.
3. Anterior jugular vein.
4. Sterno-mastoid artery.
5. Descendens hypoglossi nerve and the ansa hypoglossi.

The *three veins* cross the common carotid from within outwards, and at different levels, viz., the *superior thyroid* near its bifurcation, the *middle thyroid* below the level of the cricoid cartilage, and the *anterior jugular* at the root of the neck; whilst, however, the thyroid veins are in immediate relation to the vessel, the anterior jugular vein is separated from it by the sterno-hyoid and sterno-thyroid muscles. The sterno-

mastoid artery, a branch of the superior thyroid, crosses the vessel obliquely as it lies within the carotid triangle. The *ramus descendens hypoglossi* proceeds downwards and inwards upon the vessel, and within its sheath. The *ansa hypoglossi* is formed upon the anterior aspect of the common carotid artery by the union of the ramus descendens hypoglossi with the ramus descendens cervicalis.

Behind, the vessel is in apposition with the longus colli and the scalenus anticus muscles below, and with the rectus capitis anticus major higher up. These intervene between it and the transverse processes of the cervical vertebræ. The gangliated cord of the sympathetic, the recurrent laryngeal nerve, and the inferior thyroid artery are also related to it posteriorly. The *sympathetic cord* descends vertically in the substance of the carotid sheath, behind the artery, and is interposed between the vessel and the prevertebral muscles; the *recurrent laryngeal nerve* is carried upwards and inwards behind the lower part of the vessel; the *inferior thyroid artery* crosses behind the carotid sheath about the level of the sixth cervical vertebra.

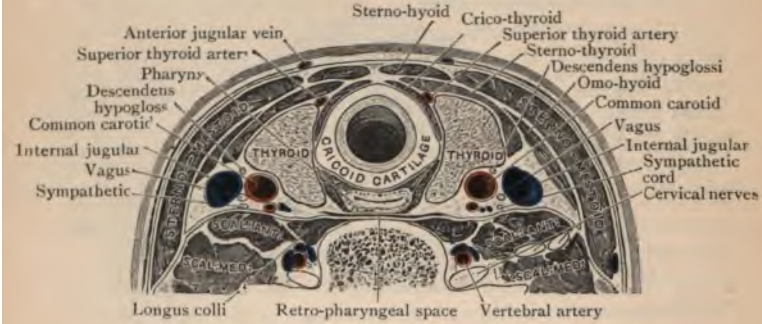

Sterno-hyoid
Crico-thyroid
Anterior jugular vein
Superior thyroid artery
Superior thyroid artery
Sterno-thyroid
Pharynx
Descendens hypoglossi
Descendens hypoglossi
Omo-hyoid
Common carotid
Common carotid
Vagus
Internal jugular
Internal jugular
Vagus
Sympathetic cord
Sympathetic
Cervical nerves
STERNO-MASTOID
STERNO-MASTOID
THYROID
THYROID
CRICOID CARTILAGE
SCAL. ANT.
SCAL. ANT.
SCAL. MED.
SCAL. MED.
Longus colli
Retro-pharyngeal space
Vertebral artery

FIG. 89.—Transverse section through the Neck at the level of the Cricoid Cartilage.

To the *outer side* of the common carotid artery lie the pneumogastric nerve and the internal jugular vein,[1] whilst

---

[1] On the left side, at the root of the neck, the internal jugular vein is closely applied to the artery—so close is it, indeed, that it may be said to overlap it. On the right side, however, the vein is separated from the artery by a slight interval, through the middle of which the vagus nerve passes down perpendicularly.

internally, it is in contact with a succession of structures as it proceeds upwards, viz., (1) the trachea and œsophagus, with the recurrent laryngeal nerve in the groove between them; (2) the lateral lobe of the thyroid body, which overlaps the vessel; (3) the larynx and the pharynx.

As a general rule, the common carotid artery gives off no collateral branches, and its calibre is of nearly equal diameter throughout, except close to its bifurcation, where a slight bulging or dilatation may usually be noticed.

Carotid Body.—This is a little oval reddish-brown body, placed upon the deep aspect of the common carotid artery at the point where it bifurcates. To expose it, therefore, the vessel must be twisted round in such a manner that its posterior surface comes to look forwards. It is closely connected with the sympathetic filaments which twine around the carotid vessels, and in structure it is similar in its nature to the minute coccygeal body which rests upon the anterior aspect of the tip of the coccyx. It is included, therefore, in the group of ductless glands. Entering it are numerous minute arterial twigs, which take origin from the termination of the common carotid and the commencement of the external carotid. The function of this remarkable little body is quite unknown. Most likely it is a vestigial structure.

External Carotid Artery (arteria carotis externa).—The external carotid artery commences at the upper border of the thyroid cartilage, and, taking an upward course, it ends in the substance of the parotid gland, immediately behind the neck of the lower jaw, by dividing into the superficial temporal and the internal maxillary arteries. It is termed *external*, not on account of its position in relation to the internal carotid, but on account of its being mainly distributed to parts on the exterior of the skull. Indeed, at its origin its position in relation to the internal carotid is the very reverse of that which its name implies. It lies in front of the internal carotid, and somewhat to its inner side. As it ascends, however, it inclines slightly backwards, so that very shortly it comes to lie directly over the internal carotid.

The external carotid artery may be divided very conveniently into three stages, corresponding to three marked changes in the relations which it presents. The first stage is contained within the carotid triangle. It is therefore, comparatively speaking, superficial. Here it is overlapped by the anterior border of the sterno-mastoid, covered by the platysma, fasciæ, and integument, and crossed by the lingual and common facial veins as they run towards the internal jugular vein. The *second stage* is more deeply placed. It lies under cover of the posterior belly of the digastric and the stylo-hyoid muscle, and is crossed by the hypoglossal nerve. The *third stage* is in relation to the parotid gland. Emerging from under cover of the digastric and stylo-hyoid muscles, the artery ascends for a short distance under cover of the lower part of the parotid gland, and finally sinks into its substance. Whilst in the parotid gland, the external carotid artery is crossed near its termination by the facial nerve, whilst the temporo-maxillary vein passes downwards *superficial to it.*

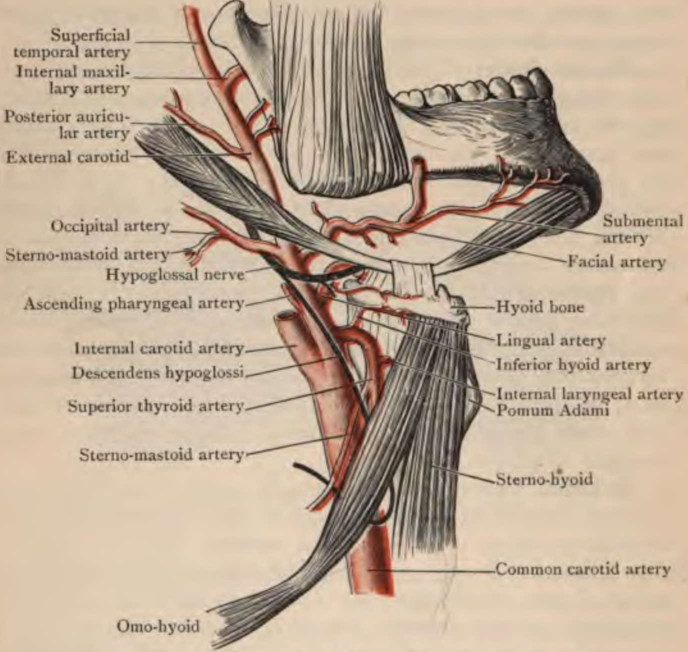

Superficial temporal artery
Internal maxillary artery
Posterior auricular artery
External carotid
Occipital artery
Sterno-mastoid artery
Hypoglossal nerve
Ascending pharyngeal artery
Internal carotid artery
Descendens hypoglossi
Superior thyroid artery
Sterno-mastoid artery
Omo-hyoid
Submental artery
Facial artery
Hyoid bone
Lingual artery
Inferior hyoid artery
Internal laryngeal artery
Pomum Adami
Sterno-hyoid
Common carotid artery

FIG. 90.—Diagram of the External Carotid Artery and its Branches.

These relations cannot be seen at present, but they will afterwards be exposed when the face is dissected. It should be noted that while the artery is in the gland it lies much nearer its deep than its superficial surface.

At its commencement, the external carotid artery lies in relation to the pharynx. Higher up it rests upon the stylopharyngeus muscle, the styloid process, and the glossopharyngeal nerve—three structures which intervene between it and the internal carotid artery.

As the external carotid ascends, it diminishes rapidly in calibre, owing to the numerous large branches which it gives off.

It is customary to classify these, according to the direction which they take, into the following groups:—

Superior thyroid, . .	Directed forwards and inwards.
Lingual, . . .	
Facial, ...	
Internal maxillary, .	
Occipital, . . .	Directed backwards and outwards.
Posterior auricular, .	
Ascending pharyngeal, .	Directed almost vertically upwards.
Superficial temporal, .	

But these are not the only branches which come off from the external carotid. Small twigs are also given to the *parotid gland*, and to the *masseter* and *internal pterygoid muscles*.

Superior Thyroid Artery (arteria thyreoidea superior).—This vessel arises within the carotid triangle, from the forepart of the external carotid close to its origin. From this it takes a curved course downwards and forwards, under cover of the omo-hyoid, sterno-hyoid, and sterno-thyroid muscles, and ends by breaking up into twigs, which enter the substance of the thyroid body.

The following branches proceed from it:—

1. Hyoid.
2. Superior laryngeal.
3. Sterno-mastoid.
4. Crico-thyroid.
5. Thyroid.

The *infra-hyoid* (ramus hyoideus) is a minute twig, which springs from the superior thyroid before it leaves the carotid triangle, and runs transversely inwards under cover of the thyro-hyoid muscle, and along the lower border of the hyoid bone. It anastomoses with its fellow of the opposite side, and with the hyoid branch of the lingual artery.

The *superior laryngeal artery* (arteria laryngea superior) is a larger vessel. It springs from the superior thyroid as it lies in the carotid triangle, and associating itself with the internal laryngeal nerve, it enters the larynx by piercing the thyro-hyoid membrane.

The *sterno-mastoid artery* (arteria sternocleidomastoidea) is a small vessel which runs downwards and outwards, along the upper border of the anterior belly of the omo-hyoid muscle, and across the carotid sheath, to reach the deep surface of the sterno-mastoid muscle, into which it sinks. It gives, in addition, minute twigs to the depressor muscles of the larynx.

The *crico-thyroid artery* (ramus cricothyreoideus) runs inwards upon the crico-thyroid membrane, and anastomoses with its fellow of the opposite side. It has already been noticed in the dissection of the middle line of the neck (p. 207).

The *thyroid* or *terminal branches* (rami glandulares) of the superior thyroid artery spring from the main trunk at the apex of the lateral lobe of the thyroid body. Three main branches may be recognised; of these the largest is distributed on the posterior surface of the lateral lobe; the smallest ramifies on its outer surface; whilst the third is carried downwards upon the inner aspect of the lateral lobe, and then along the upper border of the isthmus towards its fellow of the opposite side. The anastomosis between the thyroid arteries of the two sides is by no means free.

The *superior thyroid vein* emerges from the upper part of the thyroid body. It receives tributaries, which, in a great measure, correspond with the branches of the artery, and crosses the upper part of the common carotid to join the internal jugular vein.

Lingual Artery (arteria lingualis).—Only a small portion of this artery is seen in the present dissection. It springs from the external carotid, a short distance above the superior thyroid. In the first instance, it takes an upward course, but very soon it changes its direction, and bends suddenly downwards to reach the upper border of the hyoid bone. Here it disappears from view by passing forwards under cover of the hyoglossus muscle, and it will subsequently be traced to its ultimate distribution in the dissection of the submaxillary region. Note in the meantime, however, that the *part under observation* lies in the carotid triangle, and that the loop which it forms is crossed by the hypoglossal nerve. One small branch, termed the *supra-hyoid artery*, springs from this part of the vessel.

The *supra-hyoid branch* (ramus hyoideus) arises from the lingual, close to the posterior margin of the hyoglossus muscle, and runs inwards along the upper margin of the hyoid bone to anastomose with the corresponding vessel of the opposite side, and also with the hyoid branch of the superior thyroid.

Facial Artery (arteria maxillaris externa).—The facial artery can be studied, at the present stage of the dissection, from its origin up to the point where it mounts upon the base of the mandible to reach the face. This is termed the *cervical part* of the facial artery. It springs from the fore-part of the external carotid, immediately above the lingual, and then proceeds upwards and forwards. Finally, it enters the face at the anterior border of the masseter muscle by passing over the base of the mandible. In its course through the neck it presents stages very similar to those already noticed in connection with the external carotid. Thus it first lies in the carotid triangle, then it disappears under cover of the posterior belly of the digastric, the stylo-hyoid muscle, and the hypoglossal nerve; and finally it is enclosed within the substance of the submaxillary gland. With regard to this latter part of the artery, it is necessary that the dissector should note: (1) that the vessel can be disengaged from the submaxillary gland by dissection without lacerating the gland structure; it is placed, as it were, in a deep furrow in the gland substance; (2) that in this part of its course it is almost horizontal, and parallel with the lower margin of the mandible; (3) that on emerging from the gland it turns abruptly upwards to reach the face; and (4) that the facial vein passes backwards and downwards superficial to the submaxillary gland.

Four named branches spring from the facial artery in the cervical part of its course:—

1. The inferior palatine.
2. The tonsillitic.
3. The submaxillary.
4. The submental.

The *inferior palatine artery* (arteria palatina ascendens) is given off for the supply of the soft palate, but it also gives branches to the tonsil and Eustachian tube. It ascends between the stylopharyngeus and styloglossus muscles. The *tonsillitic artery* (ramus tonsillaris) goes to the tonsil, and at present is seen disappearing between the internal pterygoid and styloglossus muscles. Both of these vessels will be traced to their destination in the deep dissection of the neck, and in the dissection of the pharynx.

The *submaxillary branches* are given to the gland during the sojourn of the facial artery in its midst.

The *submental artery* (arteria submentalis) is a branch of some size. It springs from the facial, close to the base of the mandible, and then runs forwards upon the mylo-hyoid muscle towards the chin. Near the symphysis it changes its direction, and is carried upwards over the base of the lower jaw, to end in branches for the muscles and integument of the chin and lower lip. In the submaxillary region it gives numerous twigs to the surrounding muscles and glands, and anastomoses with the sublingual artery by branches which pierce the mylo-hyoid muscle. In the face it anastomoses with the inferior labial branch of the facial and the mental branch of the inferior dental.

Facial Vein (vena facialis anterior).—The *cervical portion* of the facial vein will be noticed passing backwards and downwards, superficial to the submaxillary gland and facial artery. After picking up tributaries corresponding to the branches of the similar part of the artery, it joins the anterior division of the temporo-maxillary vein. The short trunk thus formed is termed the *common facial vein*, and it pours its blood into the internal jugular at the level of the hyoid bone.

Internal Maxillary Artery (arteria maxillaris interna).—This vessel will be displayed in the dissection of the pterygo-maxillary space.

Occipital Artery (arteria occipitalis).—The occipital artery springs from the posterior aspect of the external carotid at the same level as the facial. It takes the lower border of the posterior belly of the digastric muscle as its guide, and runs upwards and backwards, under cover of the sterno-mastoid muscle, to reach the interval between the mastoid portion of the base of the skull and the transverse process of the atlas. From this onwards it has been studied in the dissection of the scalp and the back of the neck (pp. 112 and 145). The first part of the vessel crosses the internal carotid artery, the vagus nerve, the spinal accessory nerve, and the internal jugular vein. The hypoglossal nerve hooks round it, and it is overlapped by the lower border of the posterior belly of the digastric muscle.

The only branches which spring from this portion of the occipital are:—(1) muscular twigs; and (2) a meningeal branch.

The *muscular twigs* (rami musculares) are given to the neighbouring muscles, and one of them, larger than the others and very constant, is termed the *sterno-mastoid branch*, because it associates itself with the spinal accessory nerve, and sinks with it into the substance of the sterno-mastoid muscle.

The *meningeal branch* (ramus meningeus) associates itself with the internal jugular vein, and can be followed upwards upon it to the jugular foramen, through which it passes into the cranium.

Posterior Auricular Artery (arteria auricularis posterior).—The posterior auricular artery will be found above the level of the posterior belly of the digastric, and, like the occipital, it takes origin from the hinder aspect of the external carotid artery. In the first part of its course it is placed deeply, and runs upwards and backwards upon the styloid process of the temporal bone to reach the interval between the mastoid process and the back of the auricle. Here it joins the posterior auricular nerve, and its further course has been studied in the dissection of the scalp (p. 111). Before gaining this point it lies under cover of the lower portion of the parotid gland.

This portion of the posterior auricular artery gives off—(1) muscular twigs; (2) a few branches to the parotid gland; and (3) the stylo-mastoid artery.

The *stylo-mastoid artery* (arteria stylomastoidea) is a slender vessel which enters the stylo-mastoid foramen upon the facial nerve. In the interior of the temporal bone it has an extensive distribution. It supplies twigs to the mastoid cells and to the tympanum, and is carried onwards in the aqueduct of Fallopius to anastomose with the petrosal branch of the middle meningeal.

Ascending Pharyngeal Artery (arteria pharyngea ascendens).—The ascending pharyngeal artery is the smallest branch of the external carotid. It takes origin a short distance from the commencement of the parent trunk, and will be recognised by its proceeding vertically upwards between the internal carotid artery and the pharynx. It will be subsequently traced in the deep dissection of the neck.

Superficial Temporal Artery (arteria temporalis superficialis).—This vessel cannot be displayed at present. In the dissection of the face the student will have an opportunity of studying it.

Thyroid Body (glandula thyreoidea).—The thyroid body may now be examined. It is a highly vascular solid body, which clasps the upper part of the trachea, and extends upwards for some distance upon each side of the larynx. In size it varies greatly in different individuals, and in females and children it is always relatively larger than in adult males. It consists of three well-marked subdivisions, viz., two lateral lobes joined across the middle line by the isthmus. Each *lateral lobe* is somewhat conical in form, its base extending downwards as far as the fifth or the sixth tracheal ring, whilst its apex rests upon the side of the thyroid cartilage. Its *superficial surface* is full and rounded, and is clothed by the pretracheal layer of cervical fascia, from which it derives a sheath, and also by the sterno-thyroid, sterno-hyoid, and omo-hyoid muscles. It is further overlapped by the sterno-mastoid muscle (Fig. 89, p. 232). Its *deep surface* is adapted to the parts upon which it lies, viz., to the side of the trachea, the cricoid cartilage, and the thyroid cartilage; whilst its *posterior border* extends backwards so as to touch the œsophagus and pharynx, and overlap the common carotid artery.

The *isthmus* of the thyroid body has already been observed in the dissection of the middle line of the neck. It is a narrow band of varying width which lies in front of the second, third, and fourth rings of the trachea, and unites the bases or lower ends of the two lateral lobes.

A still further lobe is generally present in connexion with the thyroid body. This is the *pyramidal* or the *middle lobe.* When present it assumes the form of an elongated slender process which springs from the isthmus on one or other side of the mesial plane (more usually on the left side), and extends upwards towards the hyoid bone. To this it may be connected by fibrous tissue, or perhaps by a narrow slip composed of muscular fibres, which receives the name of *levator glandulæ thyreoideæ.* In some cases this little muscle has an attachment to the thyroid body independently of the *pyramidal process.* The thyroid body is firmly connected to the parts upon which it lies, and therefore follows the larynx in all its movements.

The dissector will not fail to be struck with the great vascularity of the thyroid body. Four large arteries, and occasionally a fifth smaller vessel, convey blood to its substance. The two *superior thyroid branches* of the external carotid arteries divide at the apex of each lateral lobe into three branches for its supply; the two *inferior thyroid branches* from the thyroid axis trunks of the subclavian arteries distribute their terminal branches to the basal portion and deep surface of each lateral lobe. The occasional artery is the *thyroidea ima*, a branch of the innominate (more rarely of the common carotid or the aortic arch), which ascends upon the anterior aspect of the trachea to reach the isthmus of the thyroid body. These thyroid arteries anastomose with each other.

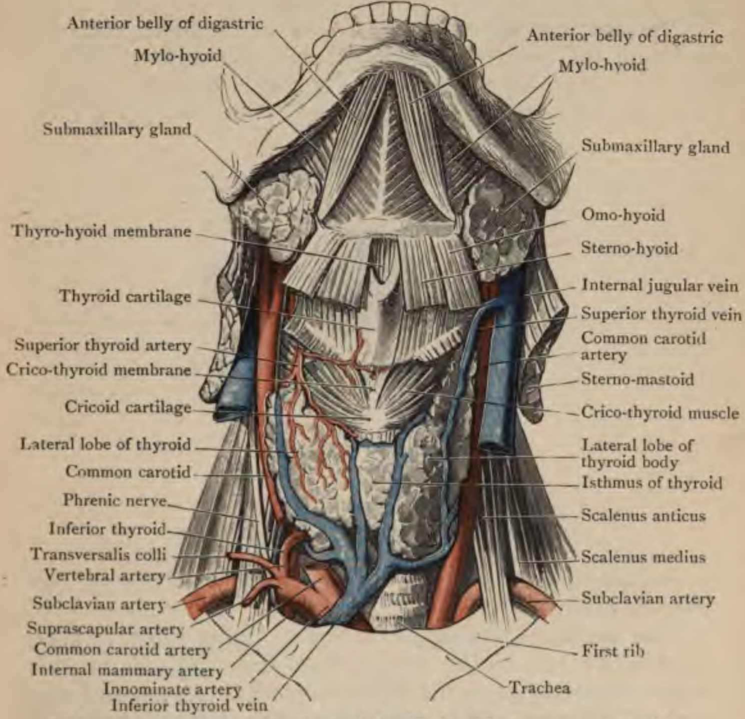

Anterior belly of digastric
Mylo-hyoid
Submaxillary gland
Thyro-hyoid membrane
Thyroid cartilage
Superior thyroid artery
Crico-thyroid membrane
Cricoid cartilage
Lateral lobe of thyroid
Common carotid
Phrenic nerve
Inferior thyroid
Transversalis colli
Vertebral artery
Subclavian artery
Suprascapular artery
Common carotid artery
Internal mammary artery
Innominate artery
Inferior thyroid vein
Anterior belly of digastric
Mylo-hyoid
Submaxillary gland
Omo-hyoid
Sterno-hyoid
Internal jugular vein
Superior thyroid vein
Common carotid artery
Sterno-mastoid
Crico-thyroid muscle
Lateral lobe of thyroid body
Isthmus of thyroid
Scalenus anticus
Scalenus medius
Subclavian artery
First rib
Trachea

FIG. 91.—Dissection of the Front of the Neck. The lower portions of the sterno-mastoid muscles have been removed, and the lower part of the right common carotid artery cut away to show the deeper parts.

The veins which drain the blood away from the thyroid body are still more numerous. They arise in part by tributaries which spring from a venous network on the anterior face of the structure, but chiefly by branches which emerge from its substance. They are *three* in number on each side —viz., the superior thyroid, the middle thyroid, and the inferior thyroid. The *superior and middle thyroid veins* cross the common carotid artery and join the internal jugular; the *inferior thyroid* descends in front of the trachea. At the root of the neck it usually joins its fellow of the opposite side to form a common stem which opens into the left innominate.

Trachea and the Œsophagus.—The windpipe and the gullet in the cervical portion of their course may now be studied. Both begin at the level of the cricoid cartilage, in front of the sixth cervical vertebra. From this point they extend downwards in front of the vertebral column to the thoracic cavity.

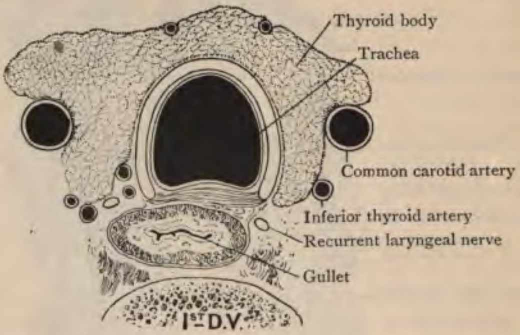


FIG. 92.—Transverse section through the Thyroid Body, Trachea, and Gullet, at the level of the first Dorsal Vertebra.

The *trachea*, or *windpipe*, is a wide tube which is kept constantly patent by the cartilaginous rings embedded in its walls. These rings do not form complete circles; posteriorly they are deficient, and in consequence the trachea is flattened behind. Above, it is continuous with the larynx, and throughout its whole course it is placed in the mesial plane of the body. The *anterior* relations of the trachea have already been fully discussed in connection with the description of the parts occupying the middle line of the neck (p. 207). *Posteriorly*, it rests upon the gullet. Upon *either side* is the common carotid artery; whilst closely applied to it in its upper part is the lateral lobe of the thyroid body. The recurrent laryngeal nerve ascends on each side in the angle between the trachea and œsophagus.

The *œsophagus* or *gullet* is a narrow tube with thick muscular walls, which extends from the pharynx to the stomach. In the cervical part of its course it lies between the trachea and the prevertebral muscles, and as it descends it inclines slightly to the left, so that it comes more closely into relation with the lateral lobe of the thyroid body and the carotid sheath upon this side than with the same structures on the opposite side.

DISSECTION OF THE FACE.

The deep parts of the neck cannot be displayed satisfactorily until the pterygo-maxillary and submaxillary regions have been opened up. It is necessary, therefore, at this stage to leave the neck and proceed with the dissection of the face.

Surface Anatomy of the Ocular Appendages.—Before the skin is reflected from the face, the external anatomy of the various appendages of the eye should be studied. Under this head we examine:—

1. The eyebrows.
2. The eyelids.
3. The conjunctiva.

The *eyebrows* are two curved tegumentary projections placed over the orbital arch of the frontal bone, so as to intervene between the forehead above and the ocular regions below. The short stiff hairs which spring from these have an outward inclination.

The *eyelids* (palpebræ) are two semilunar curtains provided for the protection of each eyeball. The upper lid is the longer and much the more movable of the two. When the eye is open the margins of the two lids are slightly concave and the interval between them is elliptical in outline. This interval is termed the *palpebral fissure* (rima palpebrarum). When the eye is closed and the margins of the lids are in apposition with each other, the palpebral fissure is reduced to a nearly horizontal line. Owing to the greater length and freer mobility of the upper lid, the fissure in this condition is placed below the level of the cornea or clear part of the eyeball.

At the extremities of the palpebral fissure the eyelids meet and form the *palpebral commissures* or *canthi*, and at the inner canthus the fissure expands into a small triangular space called the *lacus lachrymalis*. If the dissector now examine the free margins of the lids he will observe that to the outer side of the lacus lachrymalis they are flat, and that in each case the eyelashes project from the anterior border, whilst the *Meibomian follicles* open along the posterior border,—a distinct interval intervening between the cilia and the gland-mouths. The small portion of the margin of each eyelid, on the other hand, which bounds the lacus lachrymalis is more horizontal in direction, somewhat rounded, and destitute both of eyelashes and Meibomian follicles. At the very point where the eyelashes in each eyelid cease, and the palpebral margin becomes rounded, a minute eminence with a central perforation will be seen. The eminence is the *papilla lachry-*

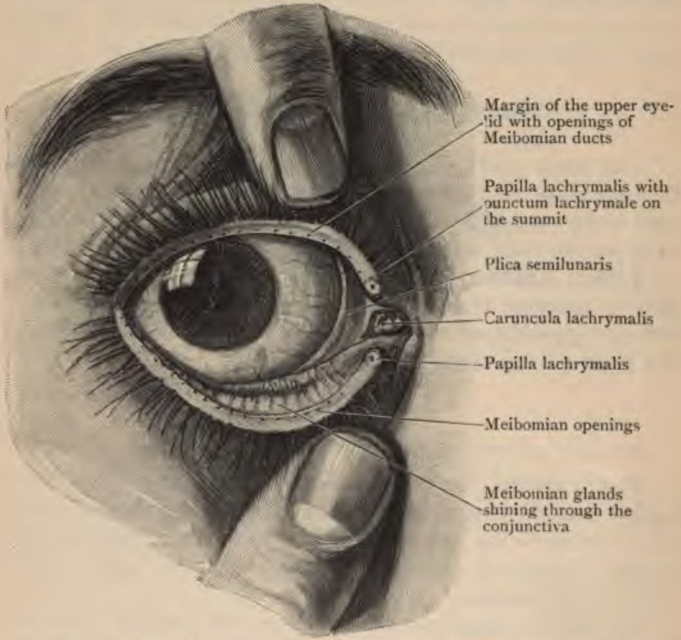

Margin of the upper eyelid with openings of Meibomian ducts
Papilla lachrymalis with punctum lachrymale on the summit
Plica semilunaris
Caruncula lachrymalis
Papilla lachrymalis
Meibomian openings
Meibomian glands shining through the conjunctiva

FIG. 93.—Eyelid slightly everted to show the Conjunctiva (enlarged).

malis, whilst the perforation, called the *punctum lachrymale*, is the mouth of the lachrymal canal, the duct which conveys away the tears. Endeavour to pass a bristle into each of the orifices. The upper canal at first for a short distance ascends, whilst the lower one descends, and then both run inwards to the lachrymal sac.

The *conjunctiva* is the membrane which lines the deep surface of both the lids, and is reflected from them on to the anterior aspect of the eyeball. At the margins of the lids it is continuous with the skin, whilst through the puncta lachrymalia and the lachrymal canals it becomes continuous with the lining membrane of the lachrymal sac. The line of reflection of the conjunctiva from the lids on to the eyeball is termed the *fornix conjunctivæ*. Owing to the greater depth of the upper lid the conjunctival recess between the upper lid and the eyeball is of greater extent than that in connexion with the lower lid. The connexion between the conjunctiva on the one hand, and the eyelids and sclerotic coat of the eyeball on the other, is of a loose character. Over the cornea, however, the membrane becomes thinned down to a mere epithelial covering, which is closely adherent.

In connexion with the conjunctiva the *plica semilunaris* and the *caruncula lachrymalis* must be examined. The caruncula is the reddish fleshy-looking elevation which occupies the centre of the lacus lachrymalis at the inner canthus. From its surface a few minute hairs project. The plica semilunaris is of interest because in the human eye it is the rudimentary representative of the membrana nictitans, or third eyelid, found in many animals. It is a small vertical fold of conjunctiva, which is placed immediately to the outer side of the caruncula, and it slightly overlaps the eyeball at this point.

Dissection.—The dissection of the face is both difficult and tedious. The ramifications of the nerves are so intricate, and the fibres of the facial muscles are so pale, and so closely surrounded by the soft subcutaneous fat of the region, that great care and patience are required on the part of the student to obtain a proper display of the various structures. In cases where the dissection is undertaken for the first time, it may be well to devote particular attention to the nerves and muscles on the one side, and to the vessels and muscles on the opposite side. At the same time it must be clearly understood that a good dissector should be able to make a complete dissection upon both sides.

It will facilitate the dissection if the student introduce under the eyelids, cheeks, and lips a small quantity of cotton-wadding or tow soaked in spirit.

The margins of the lips may then be stitched together. In doing this it is necessary to employ a fine needle. Only one incision is required for the reflection of the skin—viz., a vertical cut carried upwards immediately in front of the ear until it meets the coronal incision which was made in reflecting the integument from the scalp. The skin may then be thrown forwards as far as the middle line of the face and removed entirely.

In raising the skin the dissector must proceed with caution. Carefully preserve the fibres of the platysma, as they pass upwards upon the lower jaw to blend with the fascia, to find insertion into the bone and mix with the fibres of certain of the facial muscles (p. 180). The little *risorius muscle* as it passes forwards from the masseteric region to the angle of the mouth is apt to be injured, and must therefore be remembered. In the case of the eyelids the skin is thin and is separated from the subjacent muscular fibres by a small amount of areolar tissue devoid of fat. Some care therefore is required on the part of the dissector to remove it successfully. Over the ala of the nose and the chin, the integument is difficult to raise on account of its density and also from its close connexion with subjacent structures.

When the skin is completely reflected, and the attachments of the platysma satisfactorily demonstrated, the latter may be turned up so as to expose the facial artery passing upwards upon the jaw.

Facial Branch of the Great Auricular Nerve.—The branch which the great auricular nerve gives to the face should be traced forwards on the cheek. Several small filaments from this will be seen to penetrate the parotid gland, for the purpose of joining the facial nerve. Others proceed forwards, and supply the skin over the parotid, masseteric, and buccal regions.

Dissection.—The parotid gland should now be defined. In doing this the greatest care must be taken not to injure the branches of the facial nerve and the transverse facial artery, as they emerge from its substance, along its upper and anterior borders. The duct also, which appears at its anterior border, must be followed forwards upon the masseter muscle. When the superficial relations of the parotid have been examined, the gland-substance must be removed piecemeal, so as to bring into view the various structures with which its deep surface is in contact, and at the same time expose the blood vessels and nerves which traverse it. This can best be effected by tracing into it the branches of the facial nerve, and the trunk of the transverse facial artery. Care must be taken not to injure the auriculo-temporal nerve, which ascends under cover of the upper part of its posterior border. The communicating twigs from the auriculo-temporal and great auricular nerves to the facial nerve must be preserved. By this dissection the termination of the external carotid artery and the temporo-maxillary vein will be displayed.

Parotid Gland (glandula parotis).—The parotid is the largest of the salivary glands. It is lodged in the niche or recess between the lower jaw and the ear, and being adapted to this recess, it presents an irregular figure. *Above*, it is limited by the zygoma. *Below*, its lower border overlaps the posterior belly of the digastric muscle, and is separated from the submaxillary gland by that partition of the deep cervical fascia which the student has already studied under the name of the stylo-maxillary ligament. *Behind*, it abuts against the auditory meatus, the mastoid process, and the sterno-mastoid muscle. In *front*, it rests against the posterior border of the masseter, the posterior margin of the ramus of the lower jaw, and the posterior border of the internal pterygoid muscle. From this aspect of the gland a thin and somewhat triangular portion of the gland termed the *facial process* is prolonged forwards for some distance upon the surface of the masseter muscle. It is from the anterior margin of the facial process towards its upper part that the duct of the gland emerges, and frequently a small detached lobule of gland substance will be observed lying upon the masseter in relation to the upper aspect of the duct (Fig. 94). This is termed the socia

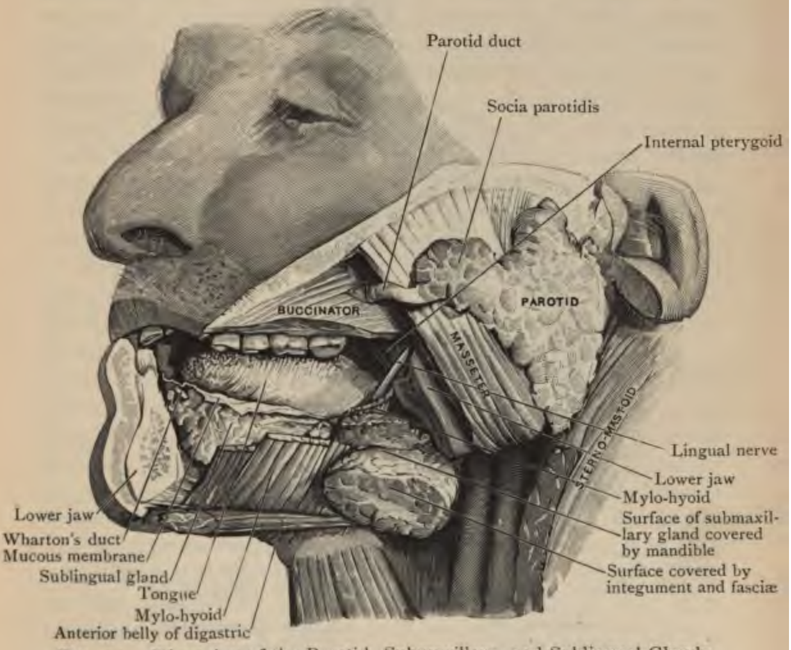

Parotid duct
Socia parotidis
Internal pterygoid
BUCCINATOR
PAROTID
MASSETER
STERNO-MASTOID
Lingual nerve
Lower jaw
Mylo-hyoid
Surface of submaxillary gland covered by mandible
Surface covered by integument and fasciæ
Lower jaw
Wharton's duct
Mucous membrane
Sublingual gland
Tongue
Mylo-hyoid
Anterior belly of digastric

FIG 94.—Dissection of the Parotid, Submaxillary, and Sublingual Glands.

parotidis. The *superficial* or *external surface* of the parotid is slightly convex, and is covered by the dense parotid fascia which the dissector has already observed to be a prolongation upwards into the face of a portion of the deep cervical fascia (p. 185). In relation to this surface, and under cover of the fascia, there are usually one or two small lymphatic glands.

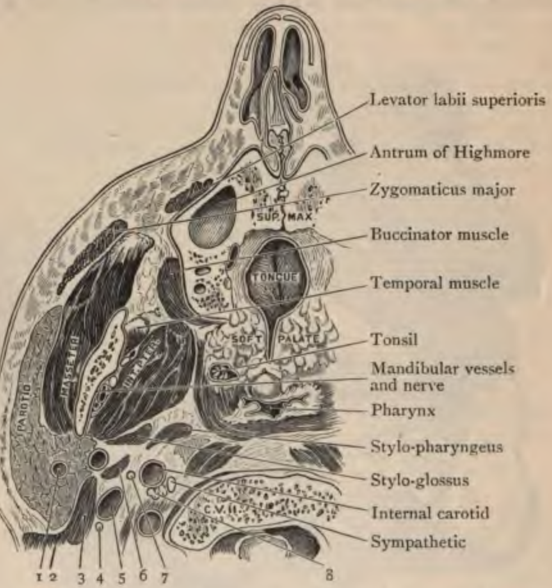

Levator labii superioris
Antrum of Highmore
Zygomaticus major
Buccinator muscle
Temporal muscle
Tonsil
Mandibular vessels and nerve
Pharynx
Stylo-pharyngeus
Stylo-glossus
Internal carotid
Sympathetic
SUP. MAX.
TONGUE
SOFT PALATE
MASSETER
PAROTID
C.V. II.
1
2
3
4
5
6
7
8

FIG. 95.—Transverse section through the Head at the level of the Hard Palate. It shows the relations of the parotid gland, etc.

1. Temporo-maxillary vein.
2. Sterno-mastoid muscle.
3. Digastric (posterior belly).
4. Spinal accessory nerve.
5. Internal jugular vein.
6. Stylo-hyoid.
7. Glosso-pharyngeal nerve.
8. Vagus and hypoglossal nerves.

The *deep surface* of the gland is in relation to many important structures, and is moulded upon the various parts with which it is in contact.

It rests upon the styloid process and the muscles which proceed from it, and is closely related to the internal jugular vein and the vagus, spinal accessory, and hypoglossal nerves. A portion of the gland substance (sometimes called the *glenoid lobe*) occupies the posterior or tympanic part of the glenoid fossa.

The *fascial connexions* of the parotid gland deserve some attention. The recess in which it lies is lined by a well-marked fascia, which separates it from subjacent structures, and we have noted the parotid fascia upon its superficial aspect. The entire gland is enveloped, therefore, in a strong envelope, which sends numerous strong septa into its substance, and accentuates its lobular appearance. The parotid fascia presents very important connexions. Above, it is attached to the zygoma; behind, it is attached to the meatus auditorius, and below that, it splits to enclose the sterno-mastoid; in front, it is continuous with the fascia over the masseter; whilst below, it is continuous with the deep cervical fascia. The front wall of this sheath in its lower part is thickened so as to form the stylo-maxillary ligament. This fascial band intervenes between the parotid gland on the one hand and the internal pterygoid muscle and a small part of the submaxillary gland on the other.

Parotid Duct (ductus parotideus).—This is also called *Stenson's duct.* It issues from the anterior border of the gland, and proceeds forwards upon the masseter muscle about half an inch below the zygoma. In relation to it above will be seen the socia parotidis and the transverse facial artery, whilst accompanying it are some branches of the facial nerve. At the anterior border of the masseter, it turns abruptly inwards through the soft fat of the cheek, and, piercing the buccinator muscle, runs forwards for a short distance between this muscle and the mucous membrane. Finally, at a point corresponding with the second molar tooth of the upper jaw, it opens into the mouth by a minute orifice placed on the summit of a small papilla. In length, the duct measures about two inches, and its course may be marked out on the surface of the cheek by drawing a line from the lower part of the external auditory meatus of the auricle to a point mid-way between the nostrils and the margin of the red part of the lip. The dissector should now open the duct, and pass a fine probe through it into the mouth. The calibre of the tube will then be observed to be greatly reduced at its opening upon the inner aspect of the cheek. Evert the cheek, and examine this orifice.

Dissection.—The parotid gland should now be removed piecemeal by following the various nerves and vessels which traverse it through its substance.

Vessels and Nerves which traverse the Parotid.—By the removal of the gland, the vessels and nerves which traverse the gland are brought into view. These are:—

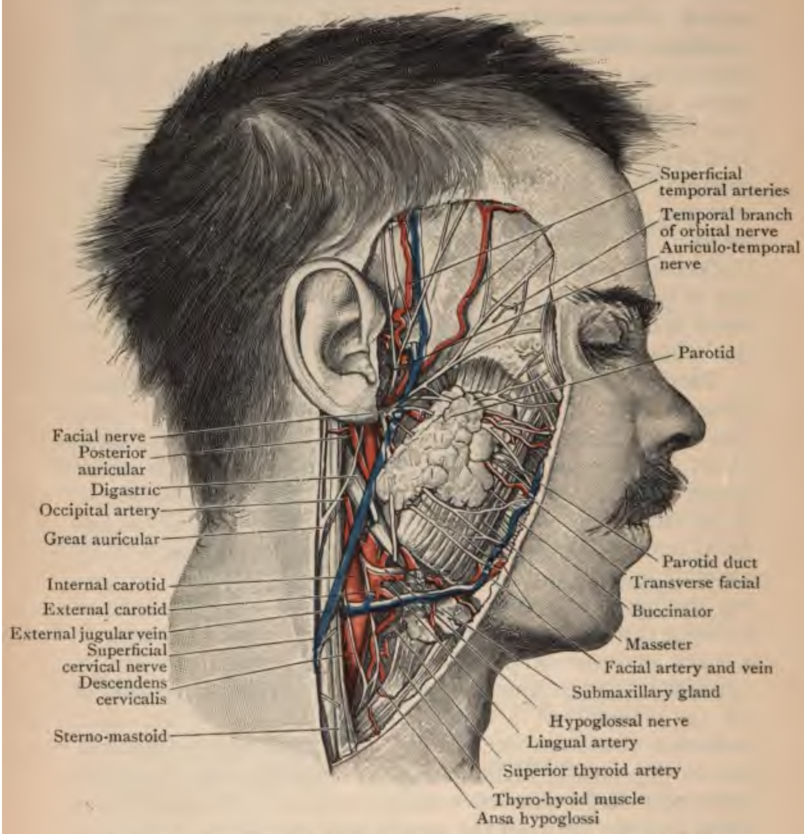

Superficial temporal arteries
Temporal branch of orbital nerve
Auriculo-temporal nerve
Parotid
Facial nerve
Posterior auricular
Digastric
Occipital artery
Great auricular
Internal carotid
External carotid
External jugular vein
Superficial cervical nerve
Descendens cervicalis
Sterno-mastoid
Parotid duct
Transverse facial
Buccinator
Masseter
Facial artery and vein
Submaxillary gland
Hypoglossal nerve
Lingual artery
Superior thyroid artery
Thyro-hyoid muscle
Ansa hypoglossi

FIG. 96.—Dissection of the Parotid Region and the upper part of the Anterior Triangle of the Neck.

1. External carotid artery, dividing into . . { Superficial temporal. / Internal maxillary.
2. Transverse facial artery.
3. Temporo-maxillary vein.
4. Facial nerve, or the seventh cranial nerve.

*5. Communi*cating twigs from the great auricular and auriculo-temporal *nerves to the facial nerve.*

The *external carotid* (arteria carotis externa), as it ascends in the substance of the gland, lies nearer its deep than its superficial surface. In fact, in the lower part of its parotid stage the artery is not placed within the gland, but merely in a groove on its deep surface, and slightly under shelter of the posterior border of the ascending ramus of the lower jaw. Note that the facial nerve crosses superficial to it, and that opposite the neck of the lower jaw the vessel divides into the superficial temporal and the internal maxillary arteries.

The *internal maxillary artery* at once passes forwards under cover of the neck of the jaw and disappears from view. The *superficial temporal artery* may now be fully followed out.

The *temporo-maxillary vein* is formed by the union of the superficial temporal and internal maxillary veins behind the neck of the lower jaw. It descends in the substance of the parotid superficial to the external carotid artery. At the lower border of the gland it divides into an anterior and posterior trunk. The former joins the facial vein, whilst the latter unites with the posterior auricular vein to form the *external jugular*.

Superficial Temporal Artery (arteria temporalis superficialis).—The superficial temporal artery appears to be the direct continuation upwards of the external carotid artery. At first in the substance of the parotid, it soon emerges from this, and, crossing the root of the zygoma, ascends upon the temporal fascia for a variable distance, and then divides into its two terminal branches, the *anterior* (ramus frontalis) and *posterior superficial temporal* (ramus parietalis) *arteries*. These are described on p. 111. The superficial temporal artery is closely accompanied by the auriculo-temporal nerve and the superficial temporal vein.

In addition to its terminal branches it gives off—

1. Parotid twigs.
2. Anterior auricular branches.
3. The transverse facial.
4. The middle temporal.
5. The orbital.

The *anterior auricular branches* (rami auriculares anteriores) supply the anterior aspect of the external auricle and anastomose with the posterior auricular artery.

The *transverse facial* (arteria transversa faciei) is given off in the substance of the parotid. It runs transversely forwards, and, emerging from under cover of the anterior border of the gland, proceeds onwards across the masseter between the zygoma and Stenson's duct to end in twigs which anastomose with branches of the facial, buccal, and infra-orbital arteries.

The *middle temporal* (arteria temporalis media) arises immediately above the zygoma, and it pierces the temporal fascia to reach the temporal muscle and communicate with the deep temporal branches of the internal maxillary artery.

The *orbital artery* (arteria zygomatico-orbitalis) is an inconstant branch which runs forwards above the zygoma between the two layers of the temporal fascia to supply the outer part of the orbicularis palpebrarum, and the skin in this neighbourhood.

Muscles of the Face.—The muscles of the face are arranged in groups around the different facial apertures. There is thus a *palpebral* and *superciliary group* in relation to each orbital opening; an *oral group* around the mouth; and a *nasal group* in connexion with the nose. Each of these groups may be examined in turn. It is convenient to begin with the palpebral and superciliary muscles. These are three in number:—

1. Orbicularis palpebrarum.
2. Tensor tarsi (Horner's muscle).
3. Corrugator supercilii.

The upper eyelid has a special elevator, termed the *levator palpebræ superioris*, but this muscle is contained within the orbital cavity, and does not come under the notice of the dissector at the present stage. The examination of the *tensor tarsi* must also be deferred until the eyelids are dissected.

Internal Tarsal Ligament.—If the eyelids be drawn outwards, a prominent cord-like ligament becomes apparent on the inner side of the inner canthus. This extends outwards from the nasal process of the superior maxillary bone to reach the eyelids, and is termed the *internal tarsal ligament.* It will be afterwards more fully examined, but it is necessary to notice it at present, seeing that it is closely connected with the origin of the orbicularis palpebrarum.

Orbicularis Palpebrarum (orbicularis oculi).—This is the sphincter muscle of the palpebral fissure. It is a thin sheet of muscular fibres, which occupies a very considerable area of the face. It is customary to regard it as being composed of two parts, a palpebral and an orbital. The *palpebral portion* is the part which lies upon the eyelids. It is thin and pale, and its fibres arise from the margins of the internal tarsal ligament. From these they sweep outwards upon the two lids, describing a series of gentle curves, and at the outer canthus they obtain attachment to the external tarsal ligament. They form a continuous layer of uniform thickness in both eyelids, except at their free margins. Here, close to the bases of the eyelashes, there is a more pronounced fasciculus, which is termed the *ciliary bundle.*

The *orbital portion* is placed upon the margin of the orbital opening; but it is not confined to this. It extends for some distance beyond it, upwards on the forehead, downwards on the cheek, and outwards so as to encroach upon the temporal region. The fasciculi which compose this part of the muscle are of a darker and coarser type. They all arise internally and sweep outwards around the orbital margin in the form of a series of concentric loops. They take origin (1) from the inner part of the internal tarsal ligament, (2) from the internal angular process of the frontal bone, and from the ascending process of the superior maxillary bone immediately in front of the lachrymal groove.

Above and to the inner side, the fasciculi of the orbicularis muscle are closely connected, and to a certain extent interlaced with the fasciculi of the frontal part of the occipito-frontalis, the corrugator supercilii and the pyramidalis nasi, whilst from its lower margin a few delicate fleshy bands are carried downwards through the soft fat to gain insertion into the skin of the cheek.

Corrugator Supercilii.—This is a small but very distinct band of dark-coloured muscular fibres which can be exposed by raising the upper and inner part of the orbicularis, with the frontalis muscle which is connected with it, from the superciliary ridge. The corrugator supercilii will then be seen arising from the inner extremity of this ridge. Its fibres pass upwards and outwards, and the greater proportion of them pass through the fasciculi of the orbicularis and frontal belly of the occipito-frontalis to gain a direct insertion into the skin of the eyebrow; one of its muscular bundles, however, joins the orbicularis, whilst a few others blend with the frontalis.

Oral Group of Muscles.—The muscles of the lips and mouth which are included in this group are the following:—

1. Orbicularis oris.
2. Zygomaticus
    - major.
    - minor.
3. Risorius.
4. Levator labii superioris alæque nasi.
5. Levator labii superioris.
6. Levator anguli oris.
7. Depressor anguli oris.
8. Depressor labii inferioris.
9. Levator menti.
10. Buccinator.

Orbicularis Oris.—The orbicularis oris is a sphincter muscle which surrounds the oral aperture. The other muscles of this group, with the exception of the levator menti, converge towards it. From the nasal process of the superior maxilla, and from the lower margin of the orbital opening, the labial slip of the levator labii superioris alæque nasi, and the levator labii superioris descend into the *upper lip*. Converging upon the *angle of the mouth*, the dissector will have little difficulty in recognising the zygomaticus major, the risorius, and the depressor anguli oris; whilst placed upon a deeper plane and extending towards the same point are the levator anguli oris and the buccinator. Entering the *lower lip* from below is the depressor labii inferioris. The play of the lips is produced by the action of these muscles antagonised to a certain extent by the orbicularis. The levator menti has little connexion with the lips. It only acts indirectly on the lower lip, as will be seen when its attachments are studied.

Dissection.—It is in dissecting these muscles that the chief difficulty will be encountered in preserving the various nerves of the face. Several large branches of the facial nerve will be found passing forwards under cover of the zygomatic muscles to reach the under surface of the levator labii superioris, where they form a complicated plexus with the infra-orbital nerve. Other branches proceed forwards upon the buccinator muscle, and enter into communication in front of the masseter with the long buccal nerve. The mandibular division of the facial nerve will also be noticed on the surface of the lower jaw. Its branches disappear under cover of the depressor anguli oris. All these nerves must be carefully followed out as the muscles are being exposed and cleaned.

Zygomaticus Major, Risorius, and Depressor Anguli Oris.—These three muscles may be grouped together, seeing that they lie in the same plane and run towards the angle of the mouth. The platysma also occupies the same plane, and many of its fibres blend with the depressor anguli oris, whilst others are carried forwards into the risorius.

The *zygomaticus major* is a long fleshy band which springs from the malar bone immediately in front of the zygomatic suture. From this it proceeds downwards and forwards, and

at the angle of the mouth some of its fibres are inserted into the skin, whilst others blend with the orbicularis oris and with the depressor anguli oris.

The *risorius* is sometimes regarded as a continuation forwards on the face of the posterior fibres of the platysma; more frequently it takes independent origin from the fascia covering the masseter, although some of its fibres come directly from the platysma. It is composed of a few slender fasciculi which pass transversely forwards in the fatty tissue

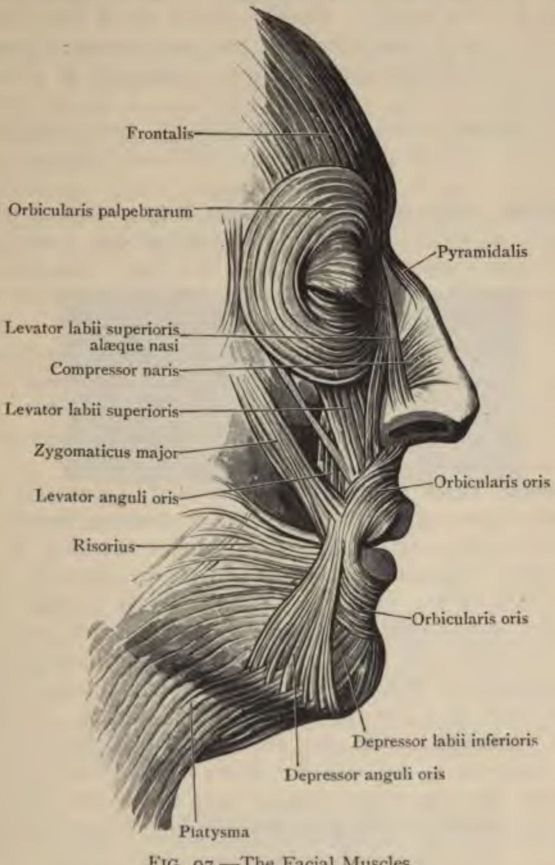

Frontalis
Orbicularis palpebrarum
Pyramidalis
Levator labii superioris alæque nasi
Compressor naris
Levator labii superioris
Zygomaticus major
Levator anguli oris
Orbicularis oris
Risorius
Orbicularis oris
Depressor labii inferioris
Depressor anguli oris
Platysma

FIG. 97.—The Facial Muscles.

of the cheek to the angle of the mouth, where they are inserted into the skin.

The *depressor anguli oris* is a flat triangular muscle which presents a broad origin from the external oblique line of the lower jaw. From this it proceeds upwards to the angle of the mouth. Here its fibres, which are collected in the form of a narrow bundle, are partly inserted into the skin, and partly prolonged into the *upper lip* in the orbicularis oris.

The *mental branch* of the mandibular nerve and its accompanying artery appear on the face under cover of this muscle.

Levator Labii Superioris Alæque Nasi.—This is a thin fleshy band which lies along the side of the nose. It is narrow above where it arises from the nasal process of the superior maxillary bone, but it expands somewhat as it proceeds downwards, and finally divides into two slips—a nasal and a labial. The *inner* and *smaller nasal slip* is inserted into the wing of the nose, whilst the *labial slip* is prolonged into the upper lip, where some of its fibres blend with the orbicularis oris, and others obtain a direct attachment to the skin.

Levator Labii Superioris.—This band-like muscle arises from the lower margin of the orbital opening, immediately above the infra-orbital foramen. It takes the form of a flat band which proceeds downwards and slightly inwards, to end in the skin of the upper lip. Under cover of this muscle the large *infra-orbital nerve* emerges on the face, and joins with branches of the facial nerve in the infra-orbital plexus.

Zygomaticus Minor.—The zygomaticus minor may be looked upon as a part of the preceding muscle. It is also closely connected with the orbicularis palpebrarum, from which some of its fasciculi are often derived, and it lies on the same plane as those slender slips which the orbicularis oris sends downwards from its lower margin to the skin of the cheek.

It is a slender fleshy bundle which arises from the malar bone in front of the zygomaticus major, and passes downwards and forwards to join the outer margin of the levator labii superioris.

Levator Anguli Oris (musculus caninus).—The origin of this muscle is hidden by the levator labii superioris. It

springs from the upper part of the canine fossa, immediately below the infra-orbital foramen, and proceeds downwards and outwards to the angle of the mouth. Here some of its fasciculi mingle with those of the orbicularis and enter the *lower lip*, whilst others gain a direct insertion into the skin.

It should be noticed that the bundle of fibres which is given by the depressor anguli oris to the upper lip, and the bundle which is contributed by the levator anguli oris to the lower lip, decussate with each other at the angle of the mouth (Fig. 99).

Depressor Labii Inferioris (quadratus labii inferioris).—The depressor labii inferioris is a quadrate muscle partially hidden by the depressor anguli oris, which overlaps it (Fig. 97). It springs from the lower jaw by a linear origin which extends from the symphysis to a point a short distance beyond the mental foramen, and passing upwards, with an inclination inwards, it joins the corresponding muscle of the opposite side, and is inserted into the skin of the lower lip. Amongst the fleshy fasciculi which compose this muscle there is a large admixture of fat, which renders it rather pale in colour.

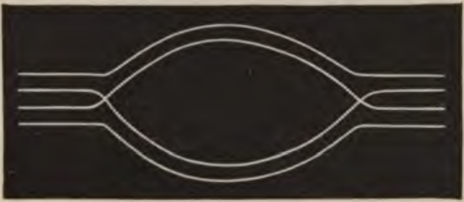


FIG. 98.—Arrangement of the Fibres of the Buccinator Muscle at the Angles of the Mouth.

Dissection.—The buccinator muscle must be cleaned with care, because branches from the facial nerve and the long buccal nerve form a plexus upon its surface, and great numbers of nerves enter it, both for the purpose of supplying it, and also for the purpose of reaching the mucous membrane of the mouth which lines its deep surface.

Buccinator Muscle.—This important muscle occupies the interval between the upper and lower jaws, and forms the chief muscular layer of the cheek. *Above* and below, its fibres take origin from the outer surface of the alveolar margins of both of these bones as far forwards as the first molar tooth. *Behind*, its posterior border is attached to the pterygo-maxillary ligament, which acts as the bond of union between it and the superior constrictor muscle of the pharynx. This attachment cannot be studied at present, but will be afterwards examined in the dissection of the pharyngeal wall. Anteriorly, it abuts against the angle of the mouth, and its fibres blend with the orbicularis oris, a large part of which it forms. But the manner in which the fibres of this muscle enter the orbicularis must be examined. The *upper* and *lower fibres* pass directly into the corresponding lip; the *middle fibres*, on the other hand, decussate at the angle of the mouth, so that the lower fibres of this series enter the upper lip, whilst the higher fasciculi reach the lower lip (Fig. 98).

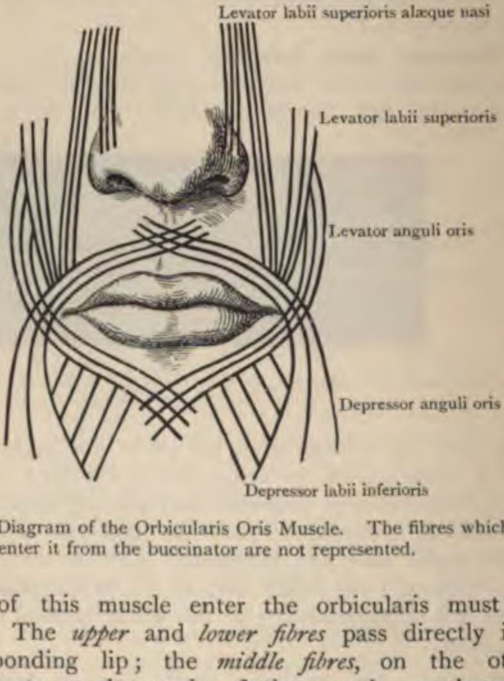

Levator labii superioris alæque nasi
Levator labii superioris
Levator anguli oris
Depressor anguli oris
Depressor labii inferioris

FIG. 99.—Diagram of the Orbicularis Oris Muscle. The fibres which enter it from the buccinator are not represented.

Orbicularis Oris.—The orbicularis oris is composed of fleshy fasciculi which sweep round the oral aperture in the interval between the skin and mucous membrane, and form a considerable part of the substance of the two lips. Its *upper margin* extends upwards as high as the nose, whilst its lower margin corresponds to the groove on the face which intervenes between the chin and the lower lip.

The fibres which compose the orbicularis oris are derived from many different sources. The chief bulk of the muscle is formed by the continuation into the lips of fibres which belong to the buccinator, the levator anguli oris, and the depressor anguli oris of each side.

The fasciculi of the buccinator muscle arrange themselves at the angle of the mouth, in the manner already described, into two bundles, and these are prolonged onwards into the two lips so as to encircle the oral aperture, and become continuous with the corresponding fasciculi of the opposite side. These fibres form the marginal part of the orbicularis, and also the deeper peripheral part. The labial portions of the levator anguli oris and the depressor anguli oris are arranged quite differently. The labial slip from the levator anguli oris passes into the lower lip, and the corresponding slip from the depressor anguli oris is continued into the upper lip. In neither case do the fibres reach the opposite angle of the mouth; they are inserted into the skin at the middle of each lip. The fibres which come from these sources form the superficial peripheral part of the orbicularis.

In addition to the fibres derived from these three muscles, the orbicularis oris receives certain slips which present special attachments. Two are provided for each side of the upper lip, viz., (1) the naso-labial band (m. naso-labialis), and (2) the superior incisive band (m. incisivus superior); and one, the inferior incisive band (m. incisivus inferior), is given to each side of the lower lip. The *naso-labial band* is a rounded bundle which arises from the lower border of the nasal septum, and turns outwards into the orbicularis oris. The *superior incisive bundle* takes origin from the incisor fossa of the superior maxilla, and turns outwards in the orbicularis; whilst the *inferior incisive bundle* arises from the corresponding fossa of the mandible, and presents similar connexions in the lower lip.

The incisive slips can be easily exposed by everting the lips, and removing the mucous membrane from the neighbourhood of these fossæ. By this dissection two other small muscles will be displayed: (1) the depressor alæ nasi to the inner side of the superior incisive slip; and (2) the levator menti to the inner side of the inferior incisive slip. The concentric arrangement of the fibres of the orbicularis oris is well seen when the mucous membrane is removed from the deep surface of the lips. Numerous labial glands which lie between the muscle and the mucous membrane are displayed by the same proceeding.

Levator Menti.—To expose this small muscle the lower lip must be everted, and the mucous membrane removed at the side of the frenum of the lower lip. It is a short, well-marked fleshy band, which springs from the incisor fossa of the lower jaw, and proceeds downwards and slightly forward, to be inserted into the skin of the chin between the two depressor muscles of the lower lip.

Nasal Group of Muscles.—Under this head are comprised:—

1. Compressor naris.
2. Levator labii superioris alæque nasi (already examined).
3. Pyramidalis nasi.
4. Depressor alæ nasi.
5. Dilatator naris posterior.
6. Dilatator naris anterior.

Compressor Naris.—This is a flat triangular muscle which springs by a pointed fleshy origin from the superior maxillary bone close to the margin of the anterior nasal aperture and under cover of the levator labii superioris alæque nasi. From this it extends inwards and upwards, and expands into an aponeurosis, which covers the cartilaginous part of the nose, and in the mesial plane becomes continuous with the corresponding aponeurosis of the opposite side.

Pyramidalis Nasi.—This narrow slip of muscular fibres springs from the aponeurosis of the compressor naris, and passes upwards upon the nasal bone. Some of the fibres gain a direct insertion into the skin over the lower part of the forehead; others are continuous with the fasciculi of the frontalis muscle.

Depressor Alæ Nasi.—This is a minute muscle, the origin of which has already been displayed by the removal of the mucous membrane at the side of the frenum of the upper lip. It springs from the incisor fossa of the superior maxilla above and to the inner side of the superior incisive slip of the orbicularis oris muscle. Its outer margin is usually more or less blended with the compressor naris, and its fibres arch upwards and forwards to become attached to the lower and back part of both the ala and the septum of the nose.

Dilatator Muscles.—These can rarely be satisfactorily displayed. The fibres which compose them are pale and feeble, and they are embedded in the dense tissue at the lower and outer part of the nose immediately above the aperture. An *anterior slip* (levator proprius alæ nasi anterior) is placed on the lower part of the side of the nose towards the fore-part of the nostril, and a *posterior slip* (levator proprius alæ nasi posterior) at a short distance behind this.

Nerves of the Face.—The nerves in this region may be divided into two sets according as they supply the skin or the muscles of the face. The motor nerve is the *nervus facialis*. The sensory nerves come from various sources, and they reach the face either directly or indirectly through the medium of filaments which join branches of the facial nerve.

The following table shows the derivation of these nerves:—

NERVES OF THE FACE.

I. **Motor.**

Facial nerve.

II. **Sensory.**

(*a*) *Appearing directly on the face.*

1. Facial branches of the great auricular nerve.
2. Branches of the trigeminal nerve (5th cranial), viz. :—

From the ophthalmic division.	Supra-orbital. Supra-trochlear. Infra-trochlear. Palpebral branch of the lachrymal. Nasal.
From the superior maxillary division.	Infra-orbital. Subcutaneus malæ. Temporal branch of the orbital.
From the inferior maxillary division.	Auriculo-temporal. Long buccal. Mental.

(*b*) *Reaching the face indirectly.*

1. Communicating branches from the great auricular nerve to the facial nerve.
2. Communicating branches from the auriculo-temporal nerve to the facial nerve.

Whilst, therefore, the motor filaments come from one source alone, the sensory nerves are derived partly from the cervical plexus through the great auricular nerve, but chiefly from the trigeminal nerve, each division of which furnishes several branches to the face.

Dissection.—The facial nerve is already, in a great measure, displayed. Its exit from the stylo-mastoid foramen can be rendered more evident by chipping off the free projecting part of the mastoid process. In doing this, first use the saw, and then complete the severance with the chisel. Care must be taken not to injure the posterior auricular branch of the facial nerve. By this proceeding a good view can be obtained of the origin of the posterior belly of the digastric, of the stylo-mastoid branch of the posterior auricular artery as it enters the foramen of the same name upon the facial nerve, and also of the occipital artery in the deepest part of its course.

Facial Nerve (nervus facialis).—The trunk of the facial nerve emerges from the stylo-mastoid foramen and proceeds forwards in the substance of the parotid gland. Near the posterior margin of the ascending ramus of the lower jaw, it ends by dividing into two branches, termed respectively the *temporo-facial* and the *cervico-facial divisions*. From this part

1. Orbicularis oris.
2. Zygomaticus
    - major.
    - minor.
3. Risorius.
4. Levator labii superioris alæque nasi.
5. Levator labii superioris.
6. Levator anguli oris.
7. Depressor anguli oris.
8. Depressor labii inferioris.
9. Levator menti.
10. Buccinator.

Orbicularis Oris.—The orbicularis oris is a sphincter muscle which surrounds the oral aperture. The other muscles of this group, with the exception of the levator menti, converge towards it. From the nasal process of the superior maxilla, and from the lower margin of the orbital opening, the labial slip of the levator labii superioris alæque nasi, and the levator labii superioris descend into the *upper lip*. Converging upon the *angle of the mouth*, the dissector will have little difficulty in recognising the zygomaticus major, the risorius, and the depressor anguli oris; whilst placed upon a deeper plane and extending towards the same point are the levator anguli oris and the buccinator. Entering the *lower lip* from below is the depressor labii inferioris. The play of the lips is produced by the action of these muscles antagonised to a certain extent by the orbicularis. The levator menti has little connexion with the lips. It only acts indirectly on the lower lip, as will be seen when its attachments are studied.

Dissection.—It is in dissecting these muscles that the chief difficulty will be encountered in preserving the various nerves of the face. Several large branches of the facial nerve will be found passing forwards under cover of the zygomatic muscles to reach the under surface of the levator labii superioris, where they form a complicated plexus with the infra-orbital nerve. Other branches proceed forwards upon the buccinator muscle, and enter into communication in front of the masseter with the long buccal nerve. The mandibular division of the facial nerve will also be noticed on the surface of the lower jaw. Its branches disappear under cover of the depressor anguli oris. All these nerves must be carefully followed out as the muscles are being exposed and cleaned.

Zygomaticus Major, Risorius, and Depressor Anguli Oris.—These three muscles may be grouped together, seeing that they lie in the same plane and run towards the angle of the mouth. The platysma also occupies the same plane, and many of its fibres blend with the depressor anguli oris, whilst others are carried forwards into the risorius.

The *zygomaticus major* is a long fleshy band which springs from the malar bone immediately in front of the zygomatic suture. From this it proceeds downwards and forwards, and

at the angle of the mouth some of its fibres are inserted into the skin, whilst others blend with the orbicularis oris and with the depressor anguli oris.

The *risorius* is sometimes regarded as a continuation forwards on the face of the posterior fibres of the platysma; more frequently it takes independent origin from the fascia covering the masseter, although some of its fibres come directly from the platysma. It is composed of a few slender fasciculi which pass transversely forwards in the fatty tissue

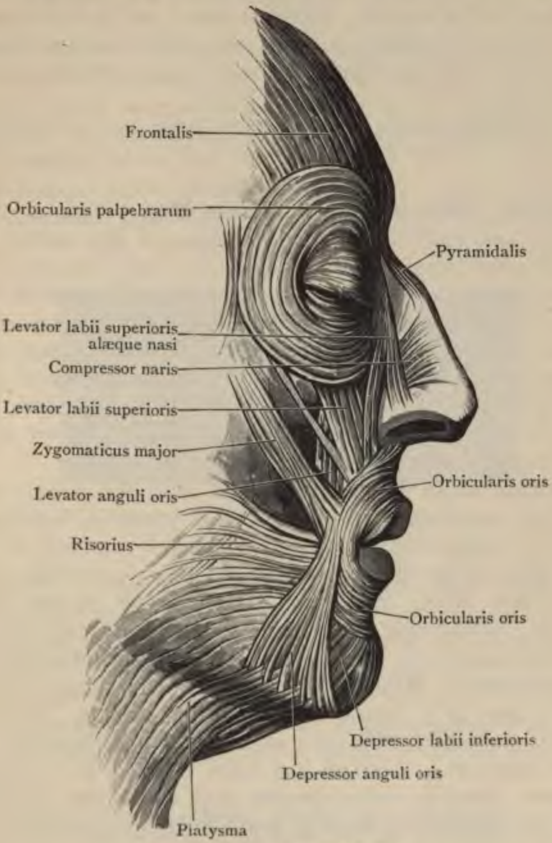

Frontalis
Orbicularis palpebrarum
Pyramidalis
Levator labii superioris alæque nasi
Compressor naris
Levator labii superioris
Zygomaticus major
Levator anguli oris
Orbicularis oris
Risorius
Orbicularis oris
Depressor labii inferioris
Depressor anguli oris
Platysma

FIG. 97.—The Facial Muscles.

of the cheek to the angle of the mouth, where they are inserted into the skin.

The *depressor anguli oris* is a flat triangular muscle which presents a broad origin from the external oblique line of the lower jaw. From this it proceeds upwards to the angle of the mouth. Here its fibres, which are collected in the form of a narrow bundle, are partly inserted into the skin, and partly prolonged into the *upper lip* in the orbicularis oris.

The *mental branch* of the mandibular nerve and its accompanying artery appear on the face under cover of this muscle.

Levator Labii Superioris Alæque Nasi.—This is a thin fleshy band which lies along the side of the nose. It is narrow above where it arises from the nasal process of the superior maxillary bone, but it expands somewhat as it proceeds downwards, and finally divides into two slips—a nasal and a labial. The *inner* and *smaller nasal slip* is inserted into the wing of the nose, whilst the *labial slip* is prolonged into the upper lip, where some of its fibres blend with the orbicularis oris, and others obtain a direct attachment to the skin.

Levator Labii Superioris.—This band-like muscle arises from the lower margin of the orbital opening, immediately above the infra-orbital foramen. It takes the form of a flat band which proceeds downwards and slightly inwards, to end in the skin of the upper lip. Under cover of this muscle the large *infra-orbital nerve* emerges on the face, and joins with branches of the facial nerve in the infra-orbital plexus.

Zygomaticus Minor.—The zygomaticus minor may be looked upon as a part of the preceding muscle. It is also closely connected with the orbicularis palpebrarum, from which some of its fasciculi are often derived, and it lies on the same plane as those slender slips which the orbicularis oris sends downwards from its lower margin to the skin of the cheek.

It is a slender fleshy bundle which arises from the malar bone in front of the zygomaticus major, and passes downwards and forwards to join the outer margin of the levator labii superioris.

Levator Anguli Oris (musculus caninus).—The origin of this muscle is hidden by the levator labii superioris. It

springs from the upper part of the canine fossa, immediately below the infra-orbital foramen, and proceeds downwards and outwards to the angle of the mouth. Here some of its fasciculi mingle with those of the orbicularis and enter the *lower lip*, whilst others gain a direct insertion into the skin.

It should be noticed that the bundle of fibres which is given by the depressor anguli oris to the upper lip, and the bundle which is contributed by the levator anguli oris to the lower lip, decussate with each other at the angle of the mouth (Fig. 99).

Depressor Labii Inferioris (quadratus labii inferioris).—The depressor labii inferioris is a quadrate muscle partially hidden by the depressor anguli oris, which overlaps it (Fig. 97). It springs from the lower jaw by a linear origin which extends from the symphysis to a point a short distance beyond the mental foramen, and passing upwards, with an inclination inwards, it joins the corresponding muscle of the opposite side, and is inserted into the skin of the lower lip. Amongst the fleshy fasciculi which compose this muscle there is a large admixture of fat, which renders it rather pale in colour.

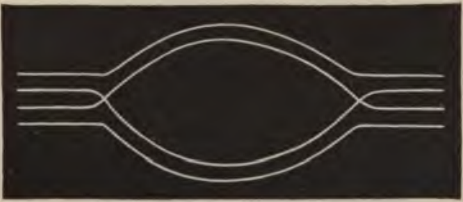


FIG. 98.—Arrangement of the Fibres of the Buccinator Muscle at the Angles of the Mouth.

Dissection.—The buccinator muscle must be cleaned with care, because branches from the facial nerve and the long buccal nerve form a plexus upon its surface, and great numbers of nerves enter it, both for the purpose of supplying it, and also for the purpose of reaching the mucous membrane of the mouth which lines its deep surface.

Buccinator Muscle.—This important muscle occupies the interval between the upper and lower jaws, and forms the chief muscular layer of the cheek. *Above* and *below*, its fibres take origin from the outer surface of the alveolar facial nerve, a plexus, and distributes palpebral, nasal, and labial branches. The *palpebral twigs* turn upwards to supply the skin and conjunctiva of the lower eyelid; the *nasal branches* incline inwards upon the side of the nose; and the *labial branches* run downwards to end in the skin and mucous membrane of the upper lip.

From the **inferior maxillary division** *of the trigeminal* three nerves are furnished to the face—viz., the auriculo-temporal, which has been described on p. 110; the long buccal nerve; and the mental nerve.

The *long buccal nerve* (n. buccinatorius) will be found coming out from under cover of the anterior border of the masseter muscle. Its branches communicate freely with the facial nerve around the facial vein, and supply the skin and the mucous membrane of the cheek. Those which go to the mucous membrane pierce the buccinator muscle.

The *mental nerve* (nervus mentalis) is a large branch of the mandibular or inferior dental nerve which appears through the mental foramen of the lower jaw under cover of the depressor anguli oris. It communicates with the facial, and supplies the mucous membrane of the lower lip, and the integument of the chin and lower lip. The mental foramen through which the nerve emerges lies directly below the interval between the two bicuspid teeth.

If a line be drawn from the supra-orbital notch to the interval between the two lower bicuspid teeth, and from that onwards to the base of the lower jaw, it will pass over or close to the infra-orbital and mental foramina. This line therefore can be used as a guide in searching for these nerves.

Arteries of the Face.—There are two main channels concerned in conveying blood to the face—viz., (1) the *transverse facial artery*, a branch of the superficial temporal, already examined (p. 251); (2) the *facial artery*, a branch of the external carotid. In addition to these a great number of smaller vessels appear on the face with the sensory branches of the trigeminal nerve. Those which accompany the branches of the ophthalmic division are derived from the ophthalmic artery, whilst those associated with the branches of the superior and inferior maxillary divisions proceed from the internal maxillary artery.

Facial Artery (arteria maxillaris externa).—The facial artery is not infrequently small in size. In such cases its

its lower margin corresponds to the groove on the face which intervenes between the chin and the lower lip.

The fibres which compose the orbicularis oris are derived from many different sources. The chief bulk of the muscle is formed by the continuation into the lips of fibres which belong to the buccinator, the levator anguli oris, and the depressor anguli oris of each side.

The fasciculi of the buccinator muscle arrange themselves at the angle of the mouth, in the manner already described, into two bundles, and these are prolonged onwards into the two lips so as to encircle the oral aperture, and become continuous with the corresponding fasciculi of the opposite side. These fibres form the marginal part of the orbicularis, and also the deeper peripheral part. The labial portions of the levator anguli oris and the depressor anguli oris are arranged quite differently. The labial slip from the levator anguli oris passes into the lower lip, and the corresponding slip from the depressor anguli oris is continued into the upper lip. In neither case do the fibres reach the opposite angle of the mouth; they are inserted into the skin at the middle of each lip. The fibres which come from these sources form the superficial peripheral part of the orbicularis.

In addition to the fibres derived from these three muscles, the orbicularis oris receives certain slips which present special attachments. Two are provided for each side of the upper lip, viz., (1) the naso-labial band (m. naso-labialis), and (2) the superior incisive band (m. incisivus superior); and one, the inferior incisive band (m. incisivus inferior), is given to each side of the lower lip. The *naso-labial band* is a rounded bundle which arises from the lower border of the nasal septum, and turns outwards into the orbicularis oris. The *superior incisive bundle* takes origin from the incisor fossa of the superior maxilla, and turns outwards in the orbicularis; whilst the *inferior incisive bundle* arises from the corresponding fossa of the mandible, and presents similar connexions in the lower lip.

The incisive slips can be easily exposed by everting the lips, and removing the mucous membrane from the neighbourhood of these fossæ. By this dissection two other small muscles will be displayed: (1) the depressor alæ nasi to the inner side of the superior incisive slip; and (2) the levator menti to the inner side of the inferior incisive slip. The concentric arrangement of the fibres of the orbicularis oris is well seen when the mucous membrane is removed from the deep surface of the lips. Numerous labial glands which lie between the muscle and the mucous membrane are displayed by the same proceeding.

Levator Menti.—To expose this small muscle the lower lip must be everted, and the mucous membrane removed at the side of the frenum of the lower lip. It is a short, well-marked fleshy band, which springs from the incisor fossa of the lower jaw, and proceeds downwards and slightly forward, to be inserted into the skin of the chin between the two depressor muscles of the lower lip.

Nasal Group of Muscles.—Under this head are comprised:—

1. Compressor naris.
2. Levator labii superioris alæque nasi (already examined).
3. Pyramidalis nasi.
4. Depressor alæ nasi.
5. Dilatator naris posterior.
6. Dilatator naris anterior.

Compressor Naris.—This is a flat triangular muscle which springs by a pointed fleshy origin from the superior maxillary bone close to the margin of the anterior nasal aperture and under cover of the levator labii superioris alæque nasi. From this it extends inwards and upwards, and expands into an aponeurosis, which covers the cartilaginous part of the nose, and in the mesial plane becomes continuous with the corresponding aponeurosis of the opposite side.

Pyramidalis Nasi.—This narrow slip of muscular fibres springs from the aponeurosis of the compressor naris, and passes upwards upon the nasal bone. Some of the fibres gain a direct insertion into the skin over the lower part of the forehead; others are continuous with the fasciculi of the frontalis muscle.

Depressor Alæ Nasi.—This is a minute muscle, the origin of which has already been displayed by the removal of the mucous membrane at the side of the frenum of the upper lip. It springs from the incisor fossa of the superior maxilla above and to the inner side of the superior incisive slip of the orbicularis oris muscle. Its outer margin is usually more or less blended with the compressor naris, and its fibres arch upwards and forwards to become attached to the lower and back part of both the ala and the septum of the nose.

Dilatator Muscles.—These can rarely be satisfactorily displayed. The fibres which compose them are pale and feeble, and they are embedded in the dense tissue at the lower and outer part of the nose immediately above the aperture. An *anterior slip* (levator proprius alæ nasi anterior) is placed on the lower part of the side of the nose towards the fore-part of the nostril, and a *posterior slip* (levator proprius alæ nasi posterior) at a short distance behind this.

Nerves of the Face.—The nerves in this region may be divided into two sets according as they supply the skin or the muscles of the face. The motor nerve is the *nervus facialis.* The sensory nerves come from various sources, and they reach the face either directly or indirectly through the medium of filaments which join branches of the facial nerve.

The following table shows the derivation of these nerves:—

NERVES OF THE FACE.

I. **Motor.**

Facial nerve.

II. **Sensory.**

(*a*) *Appearing directly on the face.*

1. Facial branches of the great auricular nerve.
2. Branches of the trigeminal nerve (5th cranial), viz.:—

From the ophthalmic division.	Supra-orbital. Supra-trochlear. Infra-trochlear. Palpebral branch of the lachrymal. Nasal.
From the superior maxillary division.	Infra-orbital. Subcutaneus malæ. Temporal branch of the orbital.
From the inferior maxillary division.	Auriculo-temporal. Long buccal. Mental.

(*b*) *Reaching the face indirectly.*

1. Communicating branches from the great auricular nerve to the facial nerve.
2. Communicating branches from the auriculo-temporal nerve to the facial nerve.

Whilst, therefore, the motor filaments come from one source alone, the sensory nerves are derived partly from the cervical plexus through the great auricular nerve, but chiefly from the trigeminal nerve, each division of which furnishes several branches to the face.

Dissection.—The facial nerve is already, in a great measure, displayed. Its exit from the stylo-mastoid foramen can be rendered more evident by chipping off the free projecting part of the mastoid process. In doing this, first use the saw, and then complete the severance with the chisel. Care must be taken not to injure the posterior auricular branch of the facial nerve. By this proceeding a good view can be obtained of the origin of the posterior belly of the digastric, of the stylo-mastoid branch of the posterior auricular artery as it enters the foramen of the same name upon the facial nerve, and also of the occipital artery in the deepest part of its course.

Facial Nerve (nervus facialis).—The trunk of the facial nerve emerges from the stylo-mastoid foramen and proceeds forwards in the substance of the parotid gland. Near the posterior margin of the ascending ramus of the lower jaw, it ends by dividing into two branches, termed respectively the *temporo-facial* and the *cervico-facial divisions.* From this part

1. Orbicularis oris.
2. Zygomaticus
   - major.
   - minor.
3. Risorius.
4. Levator labii superioris alæque nasi.
5. Levator labii superioris.
6. Levator anguli oris.
7. Depressor anguli oris.
8. Depressor labii inferioris.
9. Levator menti.
10. Buccinator.

Orbicularis Oris.—The orbicularis oris is a sphincter muscle which surrounds the oral aperture. The other muscles of this group, with the exception of the levator menti, converge towards it. From the nasal process of the superior maxilla, and from the lower margin of the orbital opening, the labial slip of the levator labii superioris alæque nasi, and the levator labii superioris descend into the *upper lip.* Converging upon the *angle of the mouth*, the dissector will have little difficulty in recognising the zygomaticus major, the risorius, and the depressor anguli oris; whilst placed upon a deeper plane and extending towards the same point are the levator anguli oris and the buccinator. Entering the *lower lip* from below is the depressor labii inferioris. The play of the lips is produced by the action of these muscles antagonised to a certain extent by the orbicularis. The levator menti has little connexion with the lips. It only acts indirectly on the lower lip, as will be seen when its attachments are studied.

Dissection.—It is in dissecting these muscles that the chief difficulty will be encountered in preserving the various nerves of the face. Several large branches of the facial nerve will be found passing forwards under cover of the zygomatic muscles to reach the under surface of the levator labii superioris, where they form a complicated plexus with the infra-orbital nerve. Other branches proceed forwards upon the buccinator muscle, and enter into communication in front of the masseter with the long buccal nerve. The mandibular division of the facial nerve will also be noticed on the surface of the lower jaw. Its branches disappear under cover of the depressor anguli oris. All these nerves must be carefully followed out as the muscles are being exposed and cleaned.

Zygomaticus Major, Risorius, and Depressor Anguli Oris.—These three muscles may be grouped together, seeing that they lie in the same plane and run towards the angle of the mouth. The platysma also occupies the same plane, and many of its fibres blend with the depressor anguli oris, whilst others are carried forwards into the risorius.

The *zygomaticus major* is a long fleshy band which springs from the malar bone immediately in front of the zygomatic suture. From this it proceeds downwards and forwards, and

at the angle of the mouth some of its fibres are inserted into the skin, whilst others blend with the orbicularis oris and with the depressor anguli oris.

The *risorius* is sometimes regarded as a continuation forwards on the face of the posterior fibres of the platysma; more frequently it takes independent origin from the fascia covering the masseter, although some of its fibres come directly from the platysma. It is composed of a few slender fasciculi which pass transversely forwards in the fatty tissue

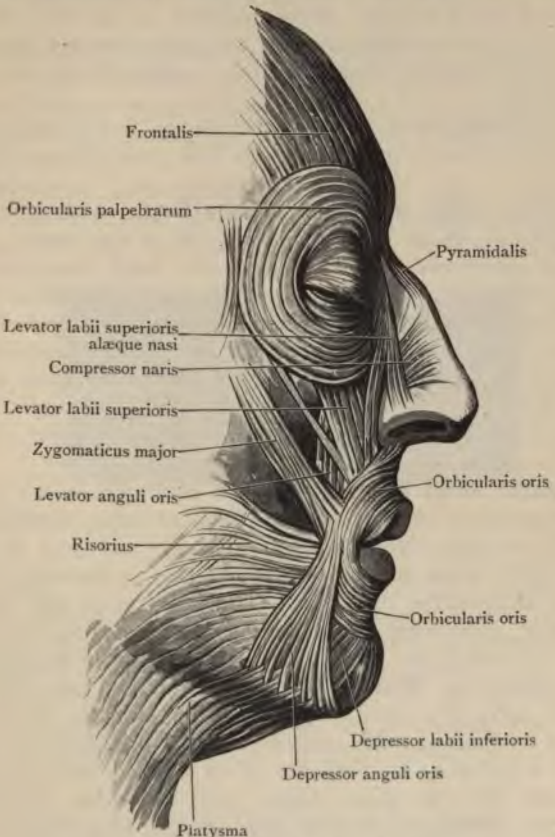

Frontalis
Orbicularis palpebrarum
Pyramidalis
Levator labii superioris alæque nasi
Compressor naris
Levator labii superioris
Zygomaticus major
Orbicularis oris
Levator anguli oris
Risorius
Orbicularis oris
Depressor labii inferioris
Depressor anguli oris
Platysma

FIG. 97.—The Facial Muscles.

of the cheek to the angle of the mouth, where they are inserted into the skin.

The *depressor anguli oris* is a flat triangular muscle which presents a broad origin from the external oblique line of the lower jaw. From this it proceeds upwards to the angle of the mouth. Here its fibres, which are collected in the form of a narrow bundle, are partly inserted into the skin, and partly prolonged into the *upper lip* in the orbicularis oris.

The *mental branch* of the mandibular nerve and its accompanying artery appear on the face under cover of this muscle.

Levator Labii Superioris Alæque Nasi.—This is a thin fleshy band which lies along the side of the nose. It is narrow above where it arises from the nasal process of the superior maxillary bone, but it expands somewhat as it proceeds downwards, and finally divides into two slips—a nasal and a labial. The *inner* and *smaller nasal slip* is inserted into the wing of the nose, whilst the *labial slip* is prolonged into the upper lip, where some of its fibres blend with the orbicularis oris, and others obtain a direct attachment to the skin.

Levator Labii Superioris.—This band-like muscle arises from the lower margin of the orbital opening, immediately above the infra-orbital foramen. It takes the form of a flat band which proceeds downwards and slightly inwards, to end in the skin of the upper lip. Under cover of this muscle the large *infra-orbital nerve* emerges on the face, and joins with branches of the facial nerve in the infra-orbital plexus.

Zygomaticus Minor.—The zygomaticus minor may be looked upon as a part of the preceding muscle. It is also closely connected with the orbicularis palpebrarum, from which some of its fasciculi are often derived, and it lies on the same plane as those slender slips which the orbicularis oris sends downwards from its lower margin to the skin of the cheek.

It is a slender fleshy bundle which arises from the malar bone in front of the zygomaticus major, and passes downwards and forwards to join the outer margin of the levator labii superioris.

Levator Anguli Oris (musculus caninus).—The origin of this muscle is hidden by the levator labii superioris. It

springs from the upper part of the canine fossa, immediately below the infra-orbital foramen, and proceeds downwards and outwards to the angle of the mouth. Here some of its fasciculi mingle with those of the orbicularis and enter the *lower lip*, whilst others gain a direct insertion into the skin.

It should be noticed that the bundle of fibres which is given by the depressor anguli oris to the upper lip, and the bundle which is contributed by the levator anguli oris to the lower lip, decussate with each other at the angle of the mouth (Fig. 99).

Depressor Labii Inferioris (quadratus labii inferioris).—The depressor labii inferioris is a quadrate muscle partially hidden by the depressor anguli oris, which overlaps it (Fig. 97). It springs from the lower jaw by a linear origin which extends from the symphysis to a point a short distance beyond the mental foramen, and passing upwards, with an inclination inwards, it joins the corresponding muscle of the opposite side, and is inserted into the skin of the lower lip. Amongst the fleshy fasciculi which compose this muscle there is a large admixture of fat, which renders it rather pale in colour.

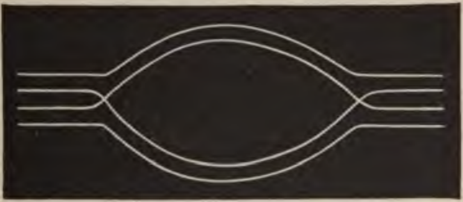


FIG. 98.—Arrangement of the Fibres of the Buccinator Muscle at the Angles of the Mouth.

Dissection.—The buccinator muscle must be cleaned with care, because branches from the facial nerve and the long buccal nerve form a plexus upon its surface, and great numbers of nerves enter it, both for the purpose of supplying it, and also for the purpose of reaching the mucous membrane of the mouth which lines its deep surface.

Buccinator Muscle.—This important muscle occupies the interval between the upper and lower jaws, and forms the chief muscular layer of the cheek. *Above* and *below*, its fibres take origin from the outer surface of the alveolar margins of both of these bones as far forwards as the first molar tooth. *Behind*, its posterior border is attached to the pterygo-maxillary ligament, which acts as the bond of union between it and the superior constrictor muscle of the pharynx. This attachment cannot be studied at present, but will be afterwards examined in the dissection of the pharyngeal wall. Anteriorly, it abuts against the angle of the mouth, and its fibres blend with the orbicularis oris, a large part of which it forms. But the manner in which the fibres of this muscle enter the orbicularis must be examined. The *upper* and *lower fibres* pass directly into the corresponding lip; the *middle fibres*, on the other hand, decussate at the angle of the mouth, so that the lower fibres of this series enter the upper lip, whilst the higher fasciculi reach the lower lip (Fig. 98).

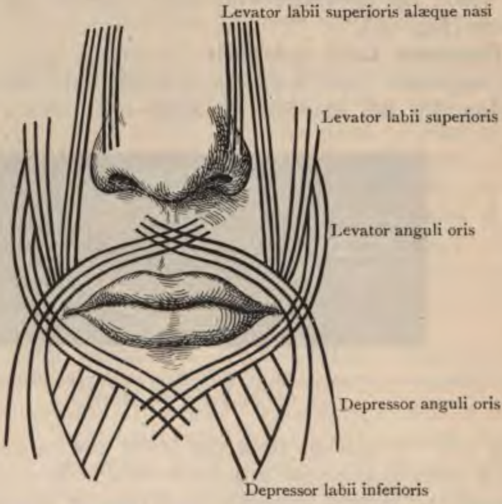

Levator labii superioris alæque nasi
Levator labii superioris
Levator anguli oris
Depressor anguli oris
Depressor labii inferioris

FIG. 99.—Diagram of the Orbicularis Oris Muscle. The fibres which enter it from the buccinator are not represented.

Orbicularis Oris.—The orbicularis oris is composed of fleshy fasciculi which sweep round the oral aperture in the interval between the skin and mucous membrane, and form a considerable part of the substance of the two lips. Its *upper margin* extends upwards as high as the nose, whilst deficiency is compensated for by an increase in the size of the transverse facial, or of some of the other vessels which appear on the face.

The course of the facial artery in the neck has already been noted (p. 237). It enters the face by passing on to the mandible immediately in front of the masseter muscle. It then takes a very tortuous course forwards and upwards to a point a short distance behind the angle of the mouth; from this it ascends to the inner canthus of the eye, and, much reduced in size by the numerous branches it has given off, it

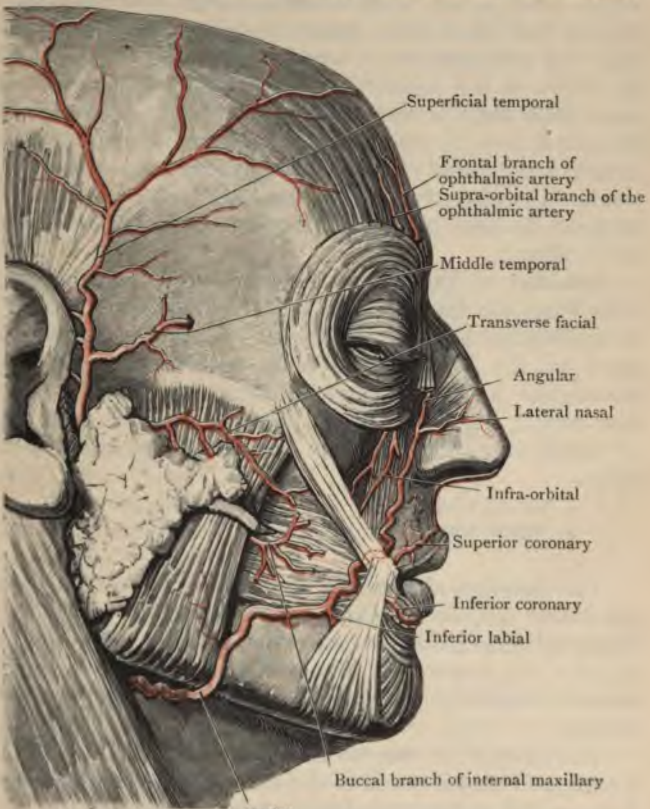

Superficial temporal
Frontal branch of ophthalmic artery
Supra-orbital branch of the ophthalmic artery
Middle temporal
Transverse facial
Angular
Lateral nasal
Infra-orbital
Superior coronary
Inferior coronary
Inferior labial
Buccal branch of internal maxillary
Facial

FIG. 101.—Arteries of the Face.

terminates by anastomosing with the nasal branch of the ophthalmic artery. Throughout its whole length it is comparatively superficial. It is true that it is placed somewhat deeply in the fat of the cheek, but the only muscles which cover it are, from below upwards: the platysma, the risorius, the zygomaticus major, and the levator labii superioris. Its terminal part is usually embedded in the midst of the fibres of the levator labii superioris alæque nasi. The parts upon which it rests as it extends through the face will be seen to be—(1) the lower jaw; (2) the buccinator; (3) the levator anguli oris. The facial vein does not accompany it closely in the face, but, above the level of the lower jaw, lies at some distance behind it. Several branches of the facial nerve cross it.

Branches of the Facial Artery.—The branches which arise from the facial artery are very numerous. Some of inconsiderable size pass *backwards*. They are distributed to parts in the buccal, masseteric, and malar regions, and anastomose with the transverse facial, the buccal, and the infra-orbital arteries. Others proceed *forwards*, and, being of larger size, they receive special designations. They are:—

1. Inferior labial.
2. Inferior coronary.
3. Superior coronary.
4. Lateral nasal.
5. Angular.

The *inferior labial* arises immediately above the base of the lower jaw, and is carried forwards under cover of the depressor anguli oris to supply the parts in connexion with the chin and lower lip. It anastomoses with the mental, the terminal branch of the submental, and the inferior coronary arteries.

The *inferior coronary* takes origin opposite the angle of the mouth, and runs inwards in the lower lip near its free margin between the mucous membrane and the orbicularis oris. In a well-injected subject it will be seen shining through the mucous membrane when the lip is everted. It anastomoses with its fellow of the opposite side and with the inferior labial.

The *superior coronary* arises under cover of the zygomaticus major, and is related to the upper lip in the same manner that the inferior coronary is related to the lower lip. It is generally of larger size. It gives off a branch called the *septal* *artery*, which runs along the lower border of the nasal septum and distributes twigs as far as the tip of the nose.

The *lateral nasal artery* is a branch which is given to the side of the nose, and as a rule passes forwards under cover of the levator labii superioris alæque nasi.

The *angular artery* is the name that is applied to the terminal part of the facial artery. It anastomoses with the nasal branch of the ophthalmic artery.

Facial Vein (vena facialis anterior). — The facial vein begins at the inner canthus of the eye, in a well-marked venous trunk called the *angular vein*, which is formed by the union of the supraorbital and frontal veins (p. 111). The course which the facial vein takes is not nearly so tortuous as that of the corresponding artery; it lies behind the artery and is separated from it by a considerable interval. Below the malar bone it proceeds in a nearly vertical direction along the anterior border of the masseter muscle, and at the base of the lower jaw the two vessels come together.

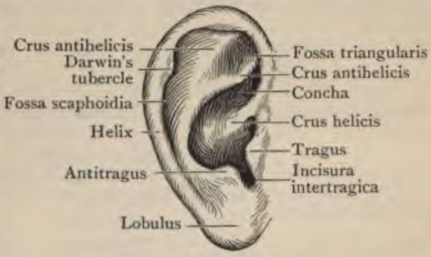


FIG. 102.—The Pinna.

Numerous tributaries join the facial vein as it courses through the face, and a large branch called the *deep facial* connects it with the pterygoid plexus of veins.

Auricle or Pinna.—Before dissecting the auricle, it is well to learn the names of its various parts, and note the position which they hold in relation to each other. The *concha* is the wide and deep fossa which leads into the external meatus; the *antihelix* is the curved prominence which bounds this posteriorly; the *helix* is the folded or incurved margin of the pinna; and the *lobule* is its soft dependent part. The concha is partially subdivided into an upper and a lower part by the commencement of the helix, which curves upwards and forwards on its floor to become continuous with the anterior border of the pinna. This portion of the helix is called the *crus helicis.* A small prominence in front of the meatus, and projecting backwards so as to overshadow it, is termed the *tragus*, whilst a similar eminence behind and below the meatus receives the name of the *antitragus*. The notch between these two prominences is termed the *incisura intertragica*. But it will be noted that the upper end of the antihelix bifurcates, and in this way two fossæ are marked off from each other; one —*the fossa of the helix*, or *scaphoid fossa*—is placed between the helix and the antihelix, and the other—*the fossa of the antihelix*, or *triangular fossa*—is situated between the two diverging terminal limbs of the antihelix.

The pinna may now be dissected. It consists of a thin plate of yellow fibro-cartilage, covered by integument. It is fixed in position by certain ligaments, and possesses two sets of feeble muscles—viz., one group termed the *extrinsic muscles*, passing to the cartilage from the aponeurosis of the occipito-frontalis and the mastoid process, and a second group in connexion with the cartilage alone, and therefore called the *intrinsic muscles*.

Ligaments, ...	Anterior. Posterior.	
Extrinsic muscles,	Attrahens. Attollens. Retrahens.	Already examined, p. 107.
Intrinsic muscles,	Musculus helicis major. Musculus helicis minor. Musculus tragicus. Musculus antitragicus.	Upon the outer face of the cartilage.
	Musculus transversus. Musculus obliquus.	Upon the cranial face of the cartilage.

The skin should be carefully removed from the entire extent of the external auricle. Particular care must be taken in the regions where the intrinsic muscles are placed.

The **auricular cartilage** extends throughout the entire pinna, with the exception of the lobule and the portion between the tragus and the helix. These portions are composed merely of integument, fatty tissue, and condensed connective tissue. The shape of the cartilage corresponds with that of the pinna itself. It shows the same elevations and depressions, and by its elasticity it serves to maintain the form of the auricle. But it also enters into the formation of the cartilaginous or outer portion of the external auditory meatus. By its inner margin this part of the cartilage is firmly fixed by fibrous tissue to the rough outer edge of the auditory process of the temporal bone, but it does not form a complete tube. It is deficient above and in front, and here the tube of the meatus is completed by tough fibrous membrane, which stretches between the tragus and the commencement of the helix.

In a successful dissection of the cartilage of the pinna, two other points will attract the attention of the student. The first is a deep slit, which passes upwards so as to separate the lower part of the cartilage of the helix, termed the *processus helicis caudatus*, from the cartilage of the antitragus; the second is a sharp spur of cartilage which projects forward from the helix at the level of the upper margin of the zygoma. This is termed *the spina helicis*.

The **ligaments of the auricle** are two in number. The *anterior* *auricular ligament* stretches from the spine of the helix to the root of the zygomatic process. The *posterior auricular ligament* will be found under cover of the retrahens auriculam. It is stronger than the preceding, and extends from a slight depression on the cranial aspect of the concha to the mastoid process.

The **intrinsic muscles** of the pinna must be sought for with care. The two muscles of the helix, the tragicus and the antitragicus, are placed upon the outer face of the cartilage. The transversus and the obliquus lie upon the cranial surface of the pinna.

The *musculus antitragicus* is the best-marked member of the outer group. It lies upon the outer surface of the antitragus, and its fibres pass obliquely upwards and backwards. Some fasciculi can be traced to the processus helicis caudatus.

The *musculus tragicus* is a minute bundle of short vertical fibres situated upon the outer surface of the tragus. When well developed a slender fasciculus may sometimes be observed to pass upwards from it to the fore-part of the helix, where it gains insertion into the spine of the helix.

The *musculus helicis major* is a well-marked band, which springs from the spina helicis, and extends upwards upon the fore-part of the helix, to be inserted into the skin which covers it.

The *musculus helicis minor* is a minute bundle of fleshy fibres which is placed upon the crus helicis as it crosses the bottom of the concha.

The *musculus transversus auriculæ* is found upon the cranial aspect of the pinna. It is generally the most strongly developed muscle of the series, and it consists of fibres bridging across the hollow which, on this aspect of the auricle, corresponds to the antihelix.

The *musculus obliquus auriculæ* is composed of some vertical fasciculi bridging across the depression which corresponds to the eminence of the lower limb of the antihelix.

Eyelids.—The following strata will be exposed in each eyelid as the student dissects from the surface towards the conjunctiva lining its deep aspect:—

UPPER LID.	LOWER LID.
1. Integument.	1. Integument.
2. Palpebral part of the orbicularis palpebrarum.	2. Palpebral part of the orbicularis palpebrarum.
3. The tarsus, the palpebral ligament, and the expanded tendon of the levator palpebræ superioris.	3. The tarsus and the palpebral ligament.
4. Conjunctiva.	4. Conjunctiva.

In addition to these structures, two ligaments named the *internal and external tarsal ligaments* will be noticed. They attach the tarsal plates to the inner and outer margins of the orbit.

The dissection should be carried on in both eyelids at the same time.

Integument and Orbicularis.—These strata have already been examined, and the skin has been reflected. The *palpebral part* of the orbicularis muscle in each lid forms a thin layer of arching muscular fibres loosely connected with the integument by some lax areolar tissue. A fasciculus, somewhat thicker than the others (ciliary bundle or muscle of Riolan) lies along the free margin of each lid, close to the bases of the eyelashes.

Dissection.—The entire orbicularis muscle may now be thrown inwards. This will show very clearly the origin of its muscular fibres at the inner margin of the orbit (p. 253). In raising the palpebral part great care must be taken to preserve the palpebral vessels and nerves, and at the same time to avoid injury to the palpebral ligament.

Tarsi.—The removal of the palpebral part of the orbicularis brings into view the palpebral ligaments and the tarsal plates. These lie in the same morphological plane, and they constitute the ground-work of the eyelids.

The *tarsi* are two thin plates of condensed connective tissue placed one in each eyelid, so as to occupy an area immediately adjoining its free margin. They differ very materially from each other. The *superior tarsal plate* is much the larger of the two, and presents the figure of a half oval. Its deep surface is intimately connected with the subjacent conjunctiva, whilst its superficial surface is clothed by the orbicularis muscle, and is in relation to the roots of the eyelashes. Its superior border is thin, convex, and continuous with the tendinous expansion of the levator palpebræ superioris. The inferior border of the tarsal plate is thickened and straight, and the integument adheres firmly to it.

The *inferior tarsal plate* is a narrow strip which is similarly placed in the lower lid.

Meibomian Follicles (glandulæ tarsales).—At this stage the attention of the student cannot fail to be attracted by the *Meibomian follicles*, which are placed on the deep surfaces of the tarsal plates. To the naked eye they appear as closely placed, parallel, yellow, granular-looking streaks, which run at right angles to the free margins of the lids. They are more numerous and of greater length in the upper lid, and, being lodged in furrows on the deep surface of the tarsal plates, they are distinctly visible upon both aspects of these, even while the conjunctiva is in position. The ducts open upon the free margin of each lid behind the eyelashes, and by the aid of a magnifying-glass they can be seen as round orifices placed in a single row.

The mouths of these glands can be well demonstrated by squeezing the eyelid between the finger and thumb, when the greasy secretion of the glands will be pressed out.

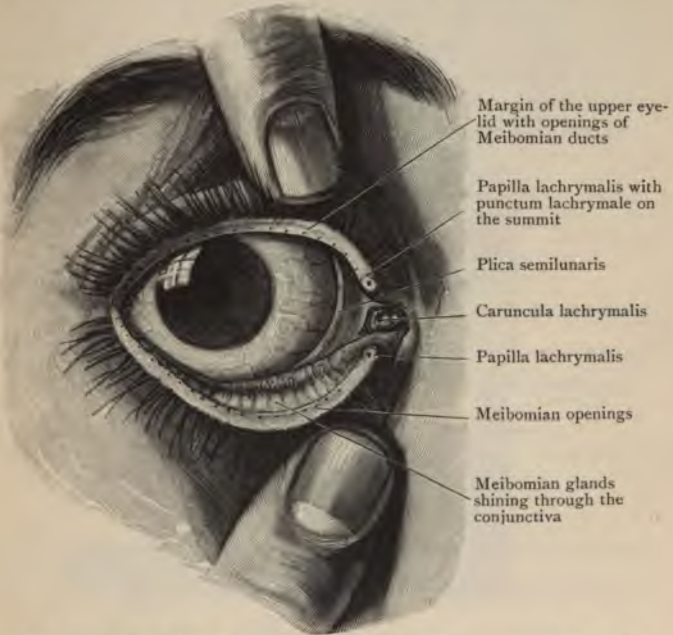

Margin of the upper eyelid with openings of Meibomian ducts
Papilla lachrymalis with punctum lachrymale on the summit
Plica semilunaris
Caruncula lachrymalis
Papilla lachrymalis
Meibomian openings
Meibomian glands shining through the conjunctiva

FIG. 103.—Eyelid slightly everted to show the Conjunctiva (enlarged).

In front of the bases of the eyelashes, between them and the ciliary muscle, are two or three rows of modified sweat-glands. These are called the glands of Moll, and when their ducts become occluded the condition familiarly known as stye results.

Palpebral Ligaments.—These are two broad membranous sheets which extend into the basal portions of the eyelids from the upper and lower margins of the orbital opening. They form an incomplete membranous diaphragm around the circumferential part of the orbital opening, termed the *septum orbitale.* The *superior ligament* blends along the orbital arch with the pericranium clothing the frontal bone, and with the periosteum lining the roof of the orbit, whilst inferiorly it blends with the expanded tendon of the levator palpebræ superioris. The *inferior ligament* is continuous on the one hand with the lower margin and anterior aspect of the lower tarsal plate, and on the other with the periosteum of the face and the floor of the orbit. Towards the inner canthus, where the eyelids are supported by the internal tarsal ligament, the palpebral ligaments become thin and delicate, and receive attachment to the lachrymal bone behind the lachrymal sac.

Tarsal Ligaments.—The palpebral ligaments fix the tarsi to the upper and lower margins of the orbit; the tarsal ligaments attach the tarsi to the outer and inner orbital margins.

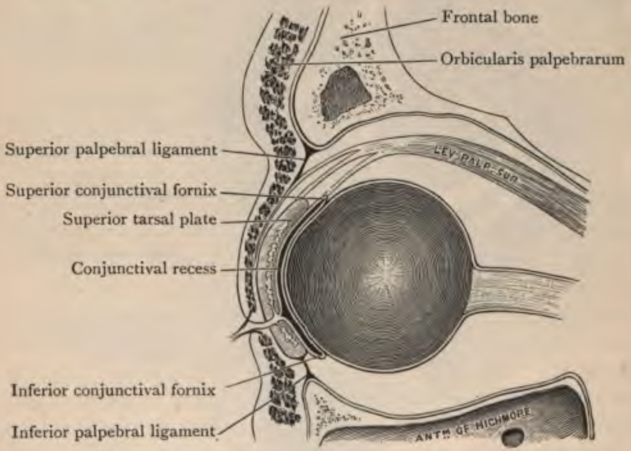

Frontal bone
Orbicularis palpebrarum
Superior palpebral ligament
LEV. PALP. SUP.
Superior conjunctival fornix
Superior tarsal plate
Conjunctival recess
Inferior conjunctival fornix
Inferior palpebral ligament
ANTM OF HIGHMORE

FIG. 104.—Diagram of the Structure of the Eyelids.

The *external tarsal ligament* is a narrow band of no great strength, which springs from the malar bone where this forms the outer margin of the orbit and proceeds inwards. At the outer canthus, it divides into two pieces, an upper and a lower, which are attached to the tarsal plates. This ligament is merely a thickening of the palpebral ligaments where they are continuous with each other at the outer margin of the orbit.

The internal tarsal ligament is a much more important structure. It has a double function to perform, viz., (1) to serve as a tendon of origin for the orbicularis muscle, and (2) to fix the tarsi to the inner margin of the orbit. To obtain a satisfactory view of it, the muscular fibres which spring from its upper and lower margins must be completely removed.

The *internal tarsal ligament* is a strong fibrous band which springs from the nasal process of the superior maxillary bone immediately in front of the lachrymal groove. It passes outwards and divides at the inner canthus into two diverging portions which are attached one to each tarsal plate.

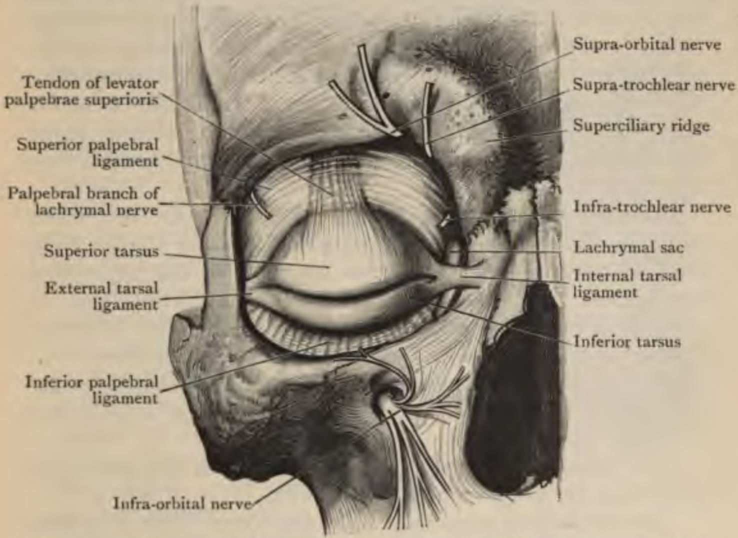

Tendon of levator palpebrae superioris
Superior palpebral ligament
Palpebral branch of lachrymal nerve
Superior tarsus
External tarsal ligament
Inferior palpebral ligament
Infra-orbital nerve
Supra-orbital nerve
Supra-trochlear nerve
Superciliary ridge
Infra-trochlear nerve
Lachrymal sac
Internal tarsal ligament
Inferior tarsus

FIG. 105.—Dissection of the Right Eyelid. The orbicularis palpebrarum has been completely removed.

The superficial surface of the internal tarsal ligament is covered by the integument; the deep surface crosses the lachrymal sac a short distance above its centre and gives to it a fibrous expansion, which is attached behind to the posterior margin of the lachrymal groove.

Dissection.—The dissection of the lower lid is now completed, but in the case of the upper eyelid the dissector must proceed to detach carefully the superior palpebral ligament from the margin of the orbit, and throw it downwards towards the tarsal plate. This will expose the expanded tendon of the levator palpebræ superioris.

Levator Palpebræ Superioris.—This muscle arises within the cavity of the orbit. Its tendon spreads out into a wide expansion which enters the basal part of the upper eyelid. It is impossible in the course of an ordinary dissection to make out all the very intricate connexions of this tendon. It splits into three laminæ. Of these the superficial layer blends with the superior palpebral ligament, and is carried forwards above the tarsal plate to the deep surface of the palpebral part of the orbicularis muscle. The intermediate stratum, largely composed of involuntary muscular fibres, is inserted into the upper border of the tarsal plate; whilst the deepest lamina is attached to the fornix conjunctivæ superior (Fig. 104).

Vessels and Nerves of the Eyelids. — At the inner canthus two arteries—the *palpebral branches* of the ophthalmic artery—appear and run outwards in the upper and lower lids. At the outer margin of the orbit, one or more branches of the *lachrymal artery* pierce the palpebral ligament, and anastomose with the palpebral arteries. An arterial arch (*arcus tarseus*) is thus formed close to the margin of each eyelid, between the orbicularis muscle and the tarsal plate.

The *veins* run inwards towards the root of the nose, and open into the frontal and angular veins.

The *nerves* are more numerous, and come from a number of different sources. The motor filaments for the palpebral part of the orbicularis proceed from the facial nerve, and enter the lids at the outer margin of the orbit. The sensory twigs for the upper lid come from the *lachrymal*, *supra-orbital*, *supra-trochlear*, and *infra-trochlear nerves*, whilst the lower lid is supplied by branches from the *infra-orbital nerve*.

Lachrymal Apparatus.—The following structures are included under this heading:—

1. The lachrymal gland and its ducts.
2. The lachrymal canals.
3. The lachrymal sac and the nasal duct.
4. The tensor tarsi muscle.

The **Lachrymal Gland** lies within the orbit, in the hollow on the roof of this cavity, at the inner side of the external angular process of the frontal bone. The fore-part of the gland projects slightly beyond the orbital margin, and rests upon the conjunctiva of the upper eyelid, as it is reflected from the lid on to the eyeball. If the gland be now raised gently and the point of the knife carried carefully up and down through the connective tissue under it, several exceedingly delicate ducts, like fine threads, will be seen proceeding from the gland. These vary greatly in number, and they open upon the under surface of the conjunctiva of the upper lid, in the neighbourhood of the fornix or the reflection of this membrane upon the anterior surface of the globe of the eye.

The tears secreted by the lachrymal gland thus reach the under surface of the upper lid, and by the involuntary closure of the lids in winking they are washed over the exposed part of the eyeball and at the same time directed inwards towards the inner canthus. From the lacus lachrymalis they are drained away by the lachrymal canals.

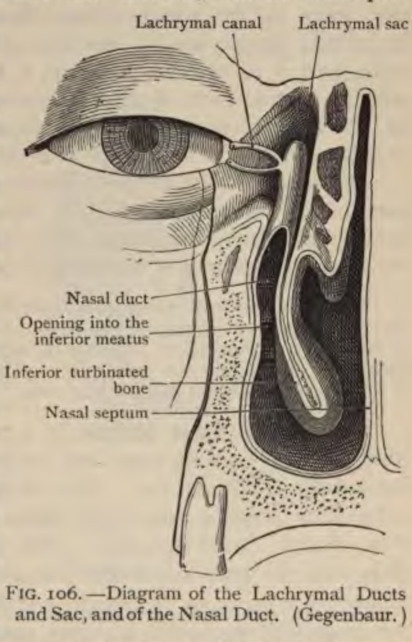


FIG. 106.—Diagram of the Lachrymal Ducts and Sac, and of the Nasal Duct. (Gegenbaur.)

The **Lachrymal Canals** (ductus lacrimales) have in a measure been already examined. The dissector has noted the *puncta lachrymalia*, or the mouths of these minute canals, upon the margins of the eyelids at the inner canthus, and he has endeavoured to determine the course pursued by each, by the introduction of a bristle. The upper canal at first ascends for a short distance, whilst the lower one descends, and then, changing their direction suddenly, they both run inwards in relation to the upper and lower margins of the internal tarsal ligament. They open close together into the outer and anterior aspect of the lachrymal sac at a point slightly above its centre. The upper canal is the smaller and longer of the two, and it inclines downwards as well as inwards to reach the lachrymal sac; the lower canal is nearly horizontal in direction.

The **Lachrymal Sac** (saccus lacrimalis) is the blind upper and somewhat expanded part of the passage which conducts the tears to the nasal cavity. It is lodged in the deep lachrymal groove in the fore-part of the inner wall of the orbit, and it is crossed in front, a short distance above its middle, by the internal tarsal ligament, from the deep surface of which it receives a fibrous expansion. The lachrymal canals open into it under cover of this ligament.

The *nasal duct* is the term which is applied to the lower part of the same passage. It descends in the bony nasal canal, and opens into the fore-part of the inferior meatus of the nose. In length it measures about half an inch.

Dissection.—In cases where the dissector is dealing with undissected eyelids, the tensor tarsi muscle can be well exposed from the deep aspect of the lids by dividing them vertically through the middle, and turning the inner portions upwards and downwards. The removal of the conjunctiva at the inner canthus will bring it into view.

The **Tensor Tarsi Muscle** is a muscular slip which can now be seen arising from the crest of the lachrymal bone behind the lachrymal sac. It is simply a deep portion of the orbicularis palpebrarum, with which it blends on the outer side of the lachrymal sac. The lachrymal canaliculi and lachrymal sac are thus enclosed in muscular fibres.

Dissection.—The cartilaginous part of the nose should now be examined by stripping off the compressor naris muscle and the remains of the integument.

Nasal Cartilages.—In addition to the septal cartilage, which will be more appropriately studied in the dissection of the nasal chambers, two cartilaginous plates will be found upon each side. These are:—

1. The upper lateral cartilage.
2. The cartilage of the aperture.

The *upper lateral cartilage* is a triangular plate which by its posterior margin is attached to the lower border of the *nasal bone* and the upper part of the sharp margin of the nasal notch of the superior maxillary bone. In the mesial plane this cartilage becomes continuous with its fellow of the opposite side, and also with the subjacent anterior border of the septal cartilage of the nose. Below, there is a slight interval between the two lateral cartilages, in which is seen the margin of the nasal septal cartilage. The inferior border of the lateral cartilage is connected with the outer part of the cartilage of the aperture by some dense fibrous tissue.

The *cartilage of the aperture* is bent upon itself and folded round the orifice of the nostril in front and laterally,—posteriorly it is deficient. The *outer part* is of an oval form, and does not reach down to the margin of the nostril, nor backwards as far as the nasal notch of the superior maxilla. The interval between it and the bone is filled in by fibrous tissue in which one or two small islands of cartilage (cartilagines minores vel sesamoideæ) appear. *In front*, the bent part of cartilage comes into contact with its neighbour and forms the point of the nose. *Internally*, the inner part of the cartilage is in the form of a narrow strip which lies upon the lower part of the septal cartilage, and projects slightly below it so as to support the margin of the nostril upon this side. Its extremity is turned slightly outwards.

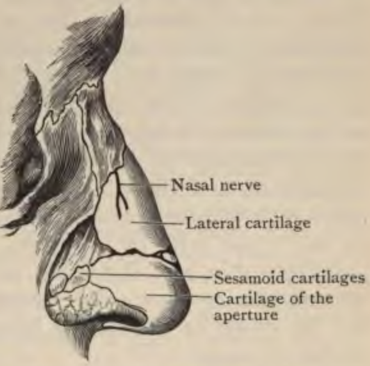


FIG. 107.—Cartilages of the Nose.

THE TEMPORAL AND PTERYGO-MAXILLARY REGIONS.

Under this heading are grouped the parts which are dissected in the temporal and zygomatic fossæ of the skull.

Dissection.—The structures which cover and lie superficial to the temporal fascia have already been examined in the dissection of the scalp (pp. 109, 110).

Throw the temporal part of the orbicularis palpebrarum forwards; preserve the middle temporal artery, and the temporal branch of the temporo-malar nerve, both of which pierce the temporal fascia; turn downwards the other vessels and nerves which lie on the temporal fascia, and remove what remains of the temporal part of the epicranial aponeurosis and of the two upper ear muscles. The temporal fascia is in this manner laid bare.

Temporal Fascia (fascia temporalis).—The temporal fascia is a strong glistening aponeurosis which is stretched over the temporal fossa, and binds down the muscle of the same name. Its upper margin is attached to the upper of the two curved lines which constitute the temporal ridge on the lateral aspect of the skull, and in front to the temporal crest of the frontal bone. As it approaches the zygomatic arch, it splits into two laminæ, which are separated from each other by a narrow interval filled with fat. These are attached to the outer and inner margins of the upper border of the zygomatic arch, and to the posterior border of the malar bone. They can readily be demonstrated by dividing the superficial layer close to its attachment, and throwing it upwards; by the handle of the knife the attachment of the deep layer can then be made out. In the upper part of its extent, the temporal fascia is comparatively thin, and the fibres of the subjacent muscle may be seen shining through it; below, it is thicker, and owing to the fat which is interposed between its laminæ it becomes perfectly opaque.

Dissection.—The masseter muscle must now be thoroughly cleaned. To do this effectually, it will be necessary to divide the trunk of the *facial nerve* immediately beyond the point where it gives off the branches to the digastric and stylo-hyoid muscles, and throw it forwards, with the various branches which spring from it, towards the buccal region. The *transverse facial artery* must be also turned backwards. The dissector will recollect that he has previously removed from the surface of the masseter a forward prolongation of the parotid gland, the socia parotidis, Stenson's duct, twigs from the great auricular nerve, scattered fibres of the platysma, and the origin of the risorius muscle.

Masseter.—The masseter is a massive quadrate muscle which lies upon the ascending ramus of the lower jaw. Its fibres are arranged in two sets—a superficial and a deep. The *superficial part* of the muscle arises from anterior two-thirds of the lower border of the zygomatic arch, and its fasciculi are directed downwards and backwards. The *deep part* springs from the whole length of the inner aspect of the zygomatic arch, and also from the posterior third of its lower border. Its fibres proceed downwards and forwards. The only portion of the deep part which appears on the surface is a small piece at the upper and back part of the muscle. The masseter is inserted into the outer surface of the ascending ramus of the mandible, over an area which extends downwards to the angle, and upwards so as to include the outer aspect of the coronoid process.

Dissection.—A dissection must now be undertaken to display the temporal muscle, and at the same time expose the nerve and artery of supply to the masseter. Begin by dividing the temporal fascia along the upper border of the zygomatic arch. It may then be thrown upwards and completely removed. The middle temporal artery and the temporal branch of the temporo-malar nerve which pierce it must be disengaged from it and preserved. The zygomatic arch with the attached masseter must next be thrown down by dividing the bony arch in front and behind the origin of the muscle. First make use of the saw, and then complete the division by means of the bone pliers. The posterior cut should be made immediately in front of the glenoid fossa, and the head of the lower jaw; the anterior cut must extend obliquely through the malar bone, from the extreme anterior end of the upper margin of the arch, downwards and forwards to the point where the lower margin meets the malar process of the superior maxillary bone. In this way the whole of the masseteric origin is included between the incisions, and the arch with the attached muscle may be readily thrown downwards towards the angle of the lower jaw. The fleshy origin of the deep portion of the masseter from the inner surface of the zygomatic arch can now be seen, and frequently the dissection is complicated by a number of fibres from the temporal muscle joining this part of the masseter. In turning the masseter down, great care must be taken not to injure its nerve and artery of supply. These pass outwards through the sigmoid notch, between the neck of the lower jaw and the posterior margin of the temporal muscle. When they are exposed and cleaned, they must be divided in order that the muscle may be fully reflected. On no account detach the masseter from the angle of the jaw. The temporal muscle may now be cleaned.

Temporal Muscle (musculus temporalis).—The temporal muscle is fan-shaped. It arises from the entire extent of the temporal fossa by an origin reaching upwards as high as the lower of the two lines which constitute the temporal ridge, and downwards as low as the infra-temporal crest on the great wing of the sphenoid. It also receives additional fibres from the deep surface of the temporal fascia which covers it. From this broad origin the fasciculi of the temporal muscle converge towards the coronoid process of the lower jaw. The anterior fibres descend vertically, the posterior fibres at first pursue a nearly horizontal course, whilst the intermediate fasciculi proceed with varying degrees of obliquity. As it approaches its insertion, a tendon is developed upon its superficial aspect, and this is inserted into the summit and anterior edge of the coronoid process of the mandible. The deep part of the muscle remains fleshy, and gains attachment to the inner surface of the same bony prominence by an insertion which reaches as low down as the point where the anterior margin of the ramus merges into the body of the mandible.

Dissection.—The next step in the dissection of this region consists in separating the coronoid process from the mandible, and turning it upwards with the attached temporal muscle. A very oblique cut is required; it should extend from the centre of the sigmoid notch above, downwards and forwards, to the point where the anterior margin of the ascending ramus meets the body of the mandible. First use the saw, and then complete the division with the bone pliers. The *long buccal nerve* and its companion *artery* are in a position of danger during this dissection, and must be carefully guarded. They proceed downwards and forwards under cover of the lower part of the temporal muscle, and not infrequently the nerve will be found traversing its substance. The coronoid process and the temporal muscle should be thrown well upwards, and the muscular fibres separated by the handle of the knife from the bone forming the lower part of the temporal fossa. This will bring into view the *deep temporal nerves* and *arteries* as they ascend between the cranial wall and the muscle. This is the time also to follow the *middle temporal artery*. It will be noticed to give branches to the muscle and extend upwards upon the squamous part of the temporal bone. The *temporal branch* of the *temporo-malar nerve* should likewise be traced to the point where it emerges from the minute aperture on the temporal surface of the malar bone. At this point it lies under cover of the temporal muscle.

The pterygoid region may now be fully opened up by removing a portion of the ascending ramus of the mandible. Two horizontal cuts must be made—one through the neck of the mandible, and the other immediately above the level of the inferior dental foramen. To find the level of the latter, the handle of the forceps should be thrust forwards between the ramus and the subjacent soft parts, and carried downwards. Its progress will soon be arrested by the entrance of the inferior dental vessels and nerve into the foramen, and the lower border of the instrument will correspond with the line along which the bone should be cut. Both incisions should be made with the saw, until the outer table of the bone is cut through, and then the bone pliers may be employed to complete the division.

Parts displayed by the above Dissection.—When the fat and areolar tissue are removed, the pterygoid muscles will come into view. The *external pterygoid* will be recognised from its extending horizontally backwards to the neck of the mandible. The *internal pterygoid*, embracing the anterior part of the external pterygoid muscle between its two heads of origin, proceeds downwards and backwards upon the deep surface of the ramus of the mandible. It bears very much the same relation to the inner aspect of the ascending ramus that the masseter presents to its outer surface. The great blood vessel of the space—the *internal maxillary artery*—proceeds forwards upon (frequently under cover of) the external pterygoid muscle. The *nerves* will also be observed to be placed in close relationship to the same muscle. Thus, emerging from between its upper border and the cranial wall at the level of the infratemporal crest are the *masseteric* and the two *deep temporal nerves*; appearing from under cover of its lower border are the *mandibular* or *inferior dental* and the *lingual nerves*; whilst the *auriculo-temporal nerve* is related to it behind, and the *long buccal nerve* in front. The former passes backwards under cover of its insertion, and appears behind the temporo-maxillary joint, and the long buccal either pierces it or emerges from between its two heads of origin. The *internal lateral ligament* of the lower jaw will likewise be seen. It is the thin strip of membrane upon which the inferior dental or mandibular nerve rests.

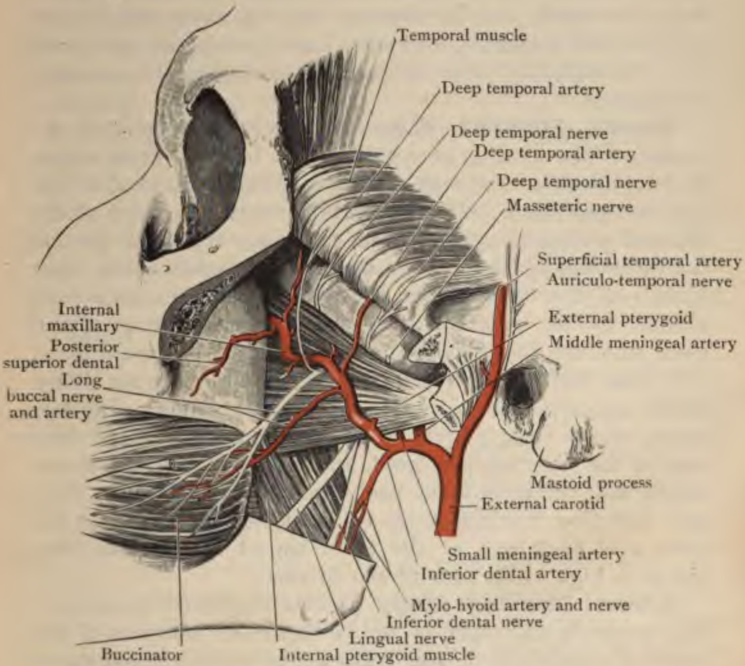

Temporal muscle
Deep temporal artery
Deep temporal nerve
Deep temporal artery
Deep temporal nerve
Masseteric nerve
Superficial temporal artery
Auriculo-temporal nerve
External pterygoid
Middle meningeal artery
Internal maxillary
Posterior superior dental
Long buccal nerve and artery
Mastoid process
External carotid
Small meningeal artery
Inferior dental artery
Mylo-hyoid artery and nerve
Inferior dental nerve
Lingual nerve
Buccinator
Internal pterygoid muscle

FIG. 108.—Dissection of the Pterygo-maxillary Space.

External Pterygoid Muscle (musculus pterygoideus externus).—The external pterygoid arises in the zygomatic fossa by two heads, an upper and a lower. The *upper head* springs from the infratemporal ridge and the zygomatic surface of the great wing of the sphenoid; the *lower head* takes origin from the outer surface of the external pterygoid plate. As the muscle passes backwards it diminishes somewhat in width, and is inserted into the fore-part of the neck of the mandible, and also into the anterior margin of the inter-articular fibro-cartilage of the temporo-maxillary articulation.

Internal Pterygoid Muscle (musculus pterygoideus internus).—The internal pterygoid is also bicipital at its origin. Its two heads embrace the origin of the lower head of the external pterygoid. The *superficial* and smaller head of the internal pterygoid springs from the lower and back part of the tuberosity of the superior maxilla and also from the outer surface of the tuberosity of the palate bone; the *deep head*, hidden by the external pterygoid, arises in the pterygoid fossa from the inner surface of the external pterygoid plate, and from the surface of the tuberosity of the palate bone, which appears between the two pterygoid plates. The two heads of the muscle unite at the lower margin of the fore-part of the external pterygoid, and its fibres proceed downwards with an inclination backwards and outwards. They gain insertion into the angle of the lower jaw, and into the lower and back part of the inner aspect of the ascending ramus as high as the mandibular foramen.

Internal Maxillary Artery (arteria maxillaris interna).—This vessel is the larger of the two terminal branches of the external carotid artery, and takes origin within the substance of the parotid gland, immediately behind the neck of the mandible. From this it proceeds forwards to the fore-part of the zygomatic fossa, where it disappears from view, by dipping between the two heads of origin of the external pterygoid muscle, and entering the spheno-maxillary fossa. It is customary to divide it into three parts for convenience in description. The *first part* runs horizontally forwards under cover of the neck of the mandible, and upon the internal lateral ligament. It lies along the lower border of the posterior part of the external pterygoid muscle, and usually crosses the inferior dental nerve. The *second part* extends obliquely upwards and forwards upon the surface of the external pterygoid muscle, and under cover of the insertion of the temporal muscle into the coronoid process of the mandible. The *third part* dips between the two heads of the external pterygoid, and is contained in the spheno-maxillary fossa.

Whilst this is the most frequent arrangement, it is by no means uncommon to find the second part of the artery lying in a deeper plane, viz., between the internal and external pterygoid muscles. In this case the vessel makes a bend outwards between the heads of the external pterygoid muscle, and appears on its surface before entering the spheno-maxillary fossa.

The *branches* of the internal maxillary artery are classified into three groups according to the portion of the vessel from which they spring. One branch only of the third part, viz., the *posterior dental* or the *superior posterior alveolar artery*, can be studied in this dissection. Those arising from the first and second parts are:—

FROM THE FIRST PART.	FROM THE SECOND PART.
1. The deep auricular.	1. Masseteric.
2. Tympanic.	2. Pterygoid.
3. Middle meningeal.	3. Anterior and posterior deep temporal.
4. Small meningeal.	4. Buccal.
5. Inferior dental.	

The *deep auricular artery* (arteria auricularis profunda) is a small vessel which pierces the anterior wall of the external auditory meatus to supply the skin which lines it, and also the superficial part of the tympanic membrane.

The *meningeal and tympanic* branches proceed upwards under cover of the external pterygoid muscle, and therefore cannot be fully studied until this muscle is reflected.

The *inferior dental artery* (arteria alveolaris inferior) arises opposite the middle meningeal, and runs downwards upon the internal lateral ligament to enter the mandibular foramen of the lower jaw. It is generally accompanied by two venæ comites, which lie one upon either side of it, and it is placed behind the inferior dental nerve. Just before entering the canal, the inferior dental artery gives off the slender *mylo-*

hyoid branch, which is carried downwards and forwards with the corresponding nerve, upon the deep aspect of the mandible, to the digastric triangle of the neck.

The branches from the second part are given off for the supply of the neighbouring muscles. The *masseteric* (arteria masseterica) passes outwards behind the temporal muscle with the nerve of the same name, and has been seen entering the masseter muscle. The *pterygoid branches* (rami pterygoidei) are a few irregular twigs, which are given to the pterygoid muscles. The *deep temporal arteries* (arteriæ temporales profundæ) are two in number—anterior and posterior—and pass upwards in the fore and hinder part of the temporal fossa, between the bony wall of the cranium and the temporal muscle. They end in twigs for the supply of the temporal muscle, and anastomose with the middle temporal artery. The *buccal artery* (arteria buccinatoria) accompanies the long buccal nerve, and is distributed to the buccinator muscle and the mucous membrane of the cheek. It anastomoses with the facial artery.

The *posterior superior dental branch* (arteria alveolaris superior posterior), from the third part of the internal maxillary artery, descends upon the posterior aspect of the superior maxilla, and sends branches through the posterior dental foramina for the supply of the upper molar and bicuspid teeth (Fig. 108). Some small twigs also go to the gum, whilst others find their way to the lining membrane of the antrum of Highmore.

Pterygoid and Internal Maxillary Veins.—The veins in this region are very numerous, but they cannot be studied satisfactorily in an ordinary dissection. They are well seen, however, when injected, in horizontal sections of the frozen head made at the level of the external pterygoid muscle. They constitute a dense plexus, termed the *pterygoid plexus*, around the external pterygoid muscle. Tributaries corresponding to the branches of the internal maxillary artery open into this network, whilst the blood is led away from its back part by a short wide trunk, called the *internal maxillary vein*. This vessel accompanies the first part of the internal maxillary artery into the parotid gland, and joins the superficial temporal vein behind the neck of the jaw, to form the *temporo-maxillary trunk*.

The pterygoid venous plexus also establishes, by various offsets, certain highly important connexions. From its forepart the *deep facial vein* proceeds; this extends forwards under cover of the lower jaw and the masseter, and unites with the facial vein. Entering its upper part are one or more minute emissary veins from the cavernous sinus. These gain the exterior of the cranium by passing through the foramen ovale. It likewise communicates with the ophthalmic vein through the spheno-maxillary fissure.

Temporo-Maxillary Articulation (articulatio mandibularis) —This joint must next be studied, in order that the external pterygoid muscle may be thrown forwards. In connexion with it we find:—

LIGAMENTS PROPER.	ACCESSORY LIGAMENTS.
1. The external lateral.	1. Internal lateral.
2. The capsular.	2. Stylo-maxillary.
An interarticular fibro-cartilage.	

The *external lateral ligament* is a strong band which is attached above to the outer surface of the posterior part of the zygomatic arch and to the tubercle at the root of the zygoma. It is composed of short parallel fibres, which proceed obliquely downwards and backwards to be inserted into the outer and hinder part of the neck of the lower jaw.

The *capsule* of the joint consists of a few scattered fibres, which support the synovial membranes upon the inner, anterior, and posterior aspects of the articulation.

The *internal lateral ligament* is a long membranous band which springs from the spinous process of the sphenoid bone, and is attached below to the lingula and to the sharp inner margin of the mandibular foramen of the lower jaw. It is not in direct relationship with the joint. Above, it lies under cover of the external pterygoid muscle; lower down, the internal maxillary artery intervenes between it and the neck of the mandible; whilst, still lower, the inferior dental vessels and nerve are interposed between it and the ramus of the mandible.

The *stylo-maxillary ligament* has already been noticed. It is an aponeurotic band, derived from the deep cervical fascia as it forms a part of the capsule of the parotid gland. It is attached on the one hand to the styloid process, and on the other to the angle and posterior border of the ramus of the jaw between the internal pterygoid and masseter muscles.

An examination of these ligaments will show that very little is added to the strength of the joint by their presence. The security of the joint depends not so much upon its ligaments as upon the strong muscles of mastication, which keep the head of the mandible in its place.

The *interarticular fibro-cartilage* is an oval plate, with its long axis directed transversely. It is interposed between the condyle of the mandible and the glenoid cavity, and divides the joint cavity into an upper and lower portion, each of which is provided with a separate synovial membrane. To expose the cartilage, the external lateral ligament must be removed. It will then be seen to be adapted to the two bony surfaces between which it lies. Above, it is concavo-convex in correspondence with the eminentia articularis and the glenoid fossa of the temporal bone; whilst below, it is concave, and fits upon the upper aspect of the condyle of the mandible. In the centre it is thin, and in some cases may be seen to be perforated. Its circumference, more especially posteriorly, is thick. It should also be noted that it is but loosely attached by its periphery to the external lateral ligament, and that anteriorly the external pterygoid muscle is partly inserted into it.

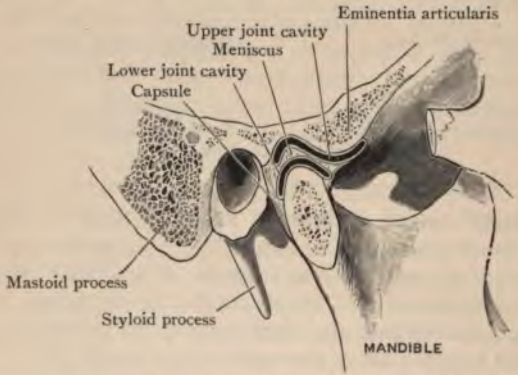


FIG. 109.—Section through Temporo-maxillary Joint.

The *synovial membrane* which lines the upper cavity of the joint is of greater extent and looser than that which lines the lower compartment. This is owing to the articular surface of the temporal bone being of larger size than the condylar surface.

Movements.—The movements which the mandible can perform at the temporo-maxillary joint are the following:—(1) depression; (2) elevation; (3) protraction; (4) retraction; (5) lateral or chewing movements. When the lower jaw is depressed the interarticular fibro-cartilage with the condyle of the mandible moves forwards in the glenoid fossa, and the latter finally takes up a position on the eminentia articularis. This forward gliding of cartilage and condyle in the upper compartment of the joint is accompanied by another movement in the lower compartment of the joint, which consists in a rotation of the condyle of the mandible on the lower surface of the interarticular fibro-cartilage. Elevation of the mandible or closure of the mouth is brought about by a reverse series of changes in both compartments of the joint. Whilst these movements are going on, the mandible rotates around a transverse axis which traverses the bone in the neighbourhood of the mandibular foramen. This is the point, therefore, of least movement, and consequently in opening and shutting the mouth the inferior dental vessels and nerves are not unduly stretched. In protraction and retraction the movement is chiefly confined to the upper compartment of the joint. The condyle of the mandible with the interarticular fibro-cartilage glides forwards and backwards upon the temporal articular surface. In the lateral movements of the jaw the mandible is carried alternately from side to side, as in the process of chewing.

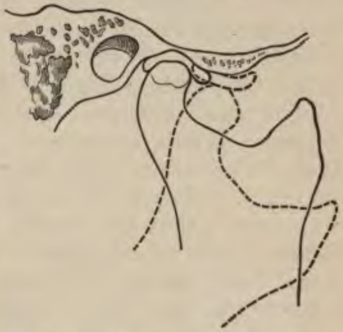


FIG. 110.—Diagram of the different positions occupied by the head of the mandible and the interarticular cartilage as the mouth is opened and closed.

The muscles on each side which are chiefly engaged in producing these movements are the following:—(1) *depressors*—the platysma, the mylohyoid, and the anterior belly of the digastric; (2) *elevators*—the masseter, internal pterygoid, temporal; (3) *protractors*—the external pterygoid, and to some extent the internal pterygoid and the superficial fibres of the masseter; (4) *retractor*—the posterior fibres of the temporal; (5) *lateral movement* is produced by certain of the muscles of opposite sides acting alternately.

Reflection of External Pterygoid.—The head of the lower jaw should now be disarticulated and thrown forwards with the attached external pterygoid muscle. It is well to detach the interarticular fibro-cartilage with the head of the bone, in order that it may be more thoroughly examined. Care must be taken not to injure the auriculo-temporal nerve, which passes backwards in close proximity to the deep aspect of the joint. When the disarticulation is complete, the muscle may be turned forwards by gently insinuating the head of the jaw under the internal maxillary artery.

The reflection of the external pterygoid muscle brings into view, after a little dissection, the *inframaxillary division* of the *trigeminal nerve*, emerging from the foramen ovale, and breaking up into its branches of distribution. The slender *chorda tympani* will likewise be found proceeding downwards and forwards to join the lingual nerve, and the *middle meningeal*, *tympanic*, and *small meningeal arteries* may be traced to the points where they leave the space.

Middle and Small Meningeal and Tympanic Arteries.—The *middle meningeal artery* (arteria meningea media) has already been seen arising from the first part of the internal maxillary artery. It proceeds upwards under cover of the external pterygoid muscle, and disappears from view by entering the foramen spinosum, and thus gaining the cranial cavity (p. 130). It will generally be observed to be embraced by the two heads of origin of the auriculo-temporal nerve.

The *small meningeal* (ramus meningeus accessorius) and *tympanic* (arteria tympanica) *arteries* arise more frequently from the preceding vessel than from the trunk of the internal maxillary. The *small meningeal* inclines forwards and upwards, and enters the cranial cavity by passing through the foramen ovale; the *tympanic* runs upwards and slightly backwards, and reaches the tympanum by passing through the Glaserian fissure. In the tympanic cavity it anastomoses with the stylo-mastoid branch of the posterior auricular artery.

Inferior Maxillary Division of the Trigeminal Nerve (nervus mandibularis).—The inferior maxillary nerve arises within the cranium from the Gasserian ganglion, and enters the pterygo-maxillary region through the foramen ovale. It is composed of *sensory fibres*, but it is accompanied through the foramen by the small *motor root* of the trigeminal nerve, and, a junction being effected between the two immediately after they gain the exterior of the cranium, a *mixed nerve-trunk* is the result. This nerve-trunk lies under cover of the external pterygoid muscle, and after a very short course (not exceeding two or three lines) it ends by dividing into two parts, named the *anterior* and *posterior divisions* of the inferior maxillary nerve (Fig. 111).

Before it divides, the trunk of the inferior maxillary nerve gives off two branches, viz., (1) the recurrent nerve (nervus spinosus), and (2) the nerve to the internal pterygoid muscle.

The *recurrent nerve* is a very slender twig which enters the cranium by accompanying the middle meningeal artery through the foramen spinosum to supply the dura mater.

The *internal pterygoid nerve* will be found passing under cover of the posterior border of the internal pterygoid muscle close to its origin. In close relation to the root of this nerve is the *otic ganglion.*

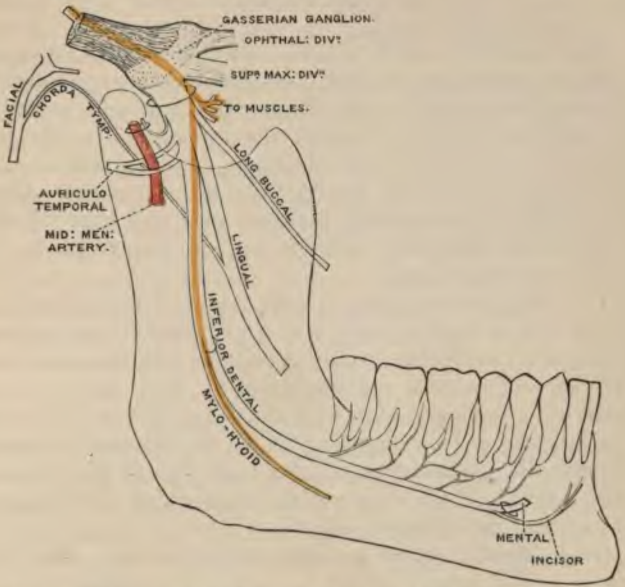

GASSERIAN GANGLION.
OPHTHAL: DIVN
SUPR MAX: DIVN
TO MUSCLES.
FACIAL
CHORDA TYMP:
AURICULO TEMPORAL
MID: MEN: ARTERY.
LONG BUCCAL
LINGUAL
INFERIOR DENTAL
MYLO-HYOID
MENTAL
INCISOR

FIG. 111.—Diagram of the Gasserian Ganglion and the Inferior Maxillary Division of the Fifth or Trigeminal Nerve. The motor root of the fifth nerve is tinted yellow.

From the two terminal divisions of the inferior maxillary trunk the chief branches of distribution arise. The *anterior division* is much the smaller of the two, and is composed almost entirely of motor fibres derived from the motor root of the trigeminal nerve. The only sensory fibres which it contains are those which form the *long buccal nerve.* It gives off the following branches:—

1. Masseteric.
2. Two deep temporal.
3. External pterygoid.
4. Long buccal.

The *large posterior division* is chiefly sensory. It contains only a very few fibres from the motor root, and these are prolonged into its inferior dental branch, and afterwards come off in the form of the *mylo-hyoid nerve.* The branches of the posterior division are:—

1. Auriculo-temporal.
2. Inferior dental.
3. Lingual (or gustatory).

The *masseteric nerve* (nervus massetericus) is directed outwards above the external pterygoid muscle, and, passing through the sigmoid notch behind the posterior border of the temporal muscle, it enters the hinder and upper part of the deep surface of the masseter. In the substance of this muscle it may be traced with the companion artery downwards and forwards to its lower and fore part. Before reaching the masseter, it gives one or two twigs to the temporo-maxillary joint.

The *deep temporal nerves* (nervi temporales profundi) are usually two in number, and are termed *anterior* and *posterior* according to the position they occupy in the temporal fossa. The posterior nerve is the smaller of the two, and frequently arises by a common root with the masseteric. Both deep temporal nerves pass outwards above the external pterygoid, and then turn upwards upon the bony wall of the cranium. After a short course they end in twigs which penetrate the substance of the temporal muscle.

Long Buccal Nerve (nervus buccinatorius).—The long buccal is the largest of the branches proceeding from the anterior division of the inferior maxillary nerve. It proceeds outwards between the two heads of the external pterygoid muscle, and then runs downwards and forwards under cover of the temporal muscle, and also of the anterior border of the masseter, to reach the outer surface of the buccinator muscle. Here it has been seen to form with branches of the facial nerve the *buccal plexus*, and to be distributed to the mucous membrane and skin of the cheek (p. 266).

The long buccal is a sensory nerve, and all the sensory fibres in the anterior division of the inferior maxillary nerve enter into its composition. A few motor fibres, however, are also prolonged into it; these come off from it in two branches, viz., (1) in the *nerve to the external pterygoid*, which as a rule arises in common with the long buccal and at once sinks into the deep surface of this muscle; and (2) in a third twig of supply to the temporal muscle. This *temporal branch* springs from the long buccal after it has reached the outer surface of the external pterygoid, and proceeds upwards to supply the fore-part of the temporal muscle (Fig. 108). In some cases the long buccal nerve may be observed to pierce the temporal muscle instead of passing under cover of it.

Auriculo-Temporal Nerve (nervus auriculo-temporalis).—The auriculo-temporal, composed of sensory fibres, springs from the posterior division of the inferior maxillary by two roots. These pass backwards under cover of the external pterygoid muscle and embrace the middle meningeal artery. Beyond this vessel they unite, and the nerve is continued backwards between the neck of the lower jaw and the internal lateral ligament. Gaining the interval between the ear and jaw, it turns upwards in relation to the deep surface of the parotid gland, and crosses the zygoma in company with the superficial temporal artery. Its further course has already been examined (p. 110).

The following branches proceed from it:—(1) one or two strong branches of communication to the temporo-facial nerve; (2) a few slender filaments which enter the posterior aspect of the temporo-maxillary joint; (3) some twigs to the parotid gland; (4) terminal filaments to the skin over the temporal region and summit of the head (p. 110); (5) auricular branches.

The *auricular* branches are usually *two* to the skin lining the interior of the external auditory meatus, and *two* to the integument over the upper and fore part of the pinna. The former gain the interior of the meatus by passing between the osseous and cartilaginous portions of the canal.

Inferior Dental Nerve (nervus alveolaris inferior).—This is the largest branch of the inferior maxillary. Emerging from under cover of the external pterygoid muscle, it passes downwards upon the internal lateral ligament of the lower jaw and enters the mandibular foramen. The inferior dental artery runs downwards behind it, whilst the lingual nerve is in front of it and upon a somewhat deeper plane. The inferior dental is a sensory nerve, but a few motor fibres from the motor root are prolonged downwards within its sheath as far as the mandibular foramen. At this point they come off as the slender *mylo-hyoid nerve.*

The *mylo-hyoid nerve*, accompanied by the artery of the same name, pierces the internal lateral ligament and proceeds downwards and forwards in a groove upon the deep surface of the lower jaw to the digastric triangle. A narrow prolongation of the internal lateral ligament bridges over the groove and holds the nerve and vessel in position. In the digastric triangle the mylo-hyoid nerve has already been dissected. It appears upon the surface of the mylo-hyoid muscle, and, issuing from under cover of the superficial part of the submaxillary gland, it breaks up into numerous branches for the supply of two muscles, viz., (1) the mylo-hyoid, and (2) the anterior belly of the digastric.

Lingual Nerve.—This nerve is entirely sensory, and is covered in the first part of its course, like the other branches of the inframaxillary nerve, by the external pterygoid muscle. Appearing at the lower border of this muscle, it proceeds downwards and forwards between the internal pterygoid muscle and the mandible and enters the submaxillary region, where it will afterwards be traced to the tongue. It is placed in front of and on a slightly deeper plane than the inferior dental nerve. In this region it gives off no branches, but, under cover of the external pterygoid, it is joined at an acute angle by the *chorda tympani branch* of the facial nerve. Not infrequently, also, a communicating twig passes between it and the inferior dental nerve.

Chorda Tympani.—This is a slender nerve which arises from the facial in the aqueduct of Fallopius. It gains the pterygo-maxillary region by traversing the tympanic cavity and appearing through the inner part of the Glaserian fissure. It will now be seen to run downwards and forwards under cover of the internal lateral ligament of the lower jaw, and unite with the lingual nerve near its origin. It is joined by a slender filament from the otic ganglion.

Otic Ganglion.—As this ganglion lies under cover of the inferior maxillary trunk, it cannot be satisfactorily studied at this stage. It is true that it may be exposed by tracing the nerve to the internal pterygoid muscle upwards, when it will be seen to be developed in connexion with the root of this ranch. Its connexions, however, can only be made out by dissecting from the inside, and it is well to defer its examination until this can be done.

Dissection.—The student should now endeavour, by means of a Hey's saw, a chisel, and the bone pliers, to remove the outer table of the lower jaw, and thus open up the mandibular canal.

Structures within the Mandibular Canal.—This canal is traversed by the *inferior dental vessels and nerve.* These give off twigs which enter the fangs of the molar and bicuspid teeth, and each terminates by dividing into a mental and incisor branch.

The *mental artery and nerve* appear on the face through the mental foramen, and have already been examined; the *incisor artery and nerve* are carried forwards to the symphysis and send up twigs to the canine and incisor teeth. The vessel anastomoses in the bone with the corresponding artery of the opposite side.

SUBMAXILLARY REGION.

The superficial area of the submaxillary region has already been dissected, under the name of the anterior part of the digastric or submaxillary triangle (p. 204). It is now necessary to carry the dissection to a deeper plane, in order to expose a number of parts in connexion with the tongue and floor of the mouth. The structures thus displayed are :—

1. Mylo-hyoid muscle.
2. Submaxillary gland and its duct.
3. Sublingual gland.
4. Side of the tongue, and the mucous membrane of the mouth.
5. Muscles.
    - Hyoglossus.
    - Stylo-glossus.
    - Genio-hyoid.
    - Genio-hyoglossus.
6. Nerves.
    - Hypoglossal.
    - Lingual.
    - Glosso-pharyngeal.
7. Submaxillary ganglion.
8. Lingual artery and veins.
9. Stylo-hyoid ligament.

Dissection.—To prepare the part for dissection, it is necessary to throw back the head to its full extent, and turn it slightly to the opposite side. If the stuffing in the mouth has not been previously removed in the dissection of the pterygo-maxillary region, it should be taken out now, and then the tip of the tongue should be seized with the forceps, and drawn forcibly forwards between the teeth, and retained in this position by stitching it to the nose.

In dissecting towards the mesial plane, three muscular strata are encountered, viz., the mylo-hyoid, the hyoglossus, the genio-hyoglossus. In the intervals between these, certain important structures will be exposed. Begin with the first muscular stratum.

The *mylo-hyoid muscle* forms the fore-part of the floor of the digastric triangle. To bring it fully into view, certain of the contents of this space must be displaced. Divide the facial artery at the point where it gains the lower jaw, and, disengaging it from the submaxillary gland, throw it downwards, along with its submental branch and the facial vein. Next, detach the anterior belly of the digastric from the mandible, and deal with it in the same manner. The mylo-hyoid nerve must also be cut, and the superficial part of the submaxillary gland turned backwards. The superficial surface of the mylo-hyoid is in this way completely exposed, and its fibres may be cleaned and its attachments made out.

Mylo-hyoid (musculus mylohyoideus). — This is a thin sheet of muscular fibres, which arises from the mylo-hyoid ridge upon the deep surface of the body of the mandible by an origin which extends from the last molar tooth behind to the symphysis in front. Its fibres are directed downwards, inwards, and backwards, and present two different modes of insertion. The posterior fibres are inserted into the body of the hyoid bone; these, however, form a comparatively small part of the muscle. The greater number of the fibres are inserted into a median raphe, which extends between the symphysis of the lower jaw and the body of the hyoid bone. The two mylo-hyoid muscles, therefore, in front of the hyoid bone stretch across from one side of the body of the mandible to the other, and constitute a floor for the anterior part of the mouth. This floor is frequently termed the *diaphragma oris.* The mylo-hyoid muscle is supplied by the *mylo-hyoid branch* of the *inferior dental nerve.*

Dissection.—The mylo-hyoid muscle must now be reflected, in order that the parts subjacent to it may be brought into view. As these parts lie in a great measure under shelter of the mandible, it is advantageous to make at the same time a section of this bone, in order that it may be turned upwards.

Carefully divide the fibres of the mylo-hyoid muscle close to the ridge from which it arises. A small piece may be left attached to the mandible to serve as a landmark in the future dissection. This must be done cautiously, else the mucous membrane of the mouth will be injured. When detached from the jaw, the muscle must next be separated from the median raphe, and then it can be thrown down over the hyoid bone. The lower jaw should next be divided, by means of the saw and bone pliers, a quarter of an inch to the outer side of the symphysis. When the section is completed, the lower margin of the mandible should be gently tilted upwards, and some means taken to retain the loose piece of the bone in this position. Under no pretence whatever should it be removed, and care must be taken to preserve intact the mucous membrane passing from the floor of the mouth to the deep surface of the gum.

Parts Exposed by the Reflection of the Mylo-hyoid (Fig. 112).—The side of the tongue is now brought into view, with a number of structures in connexion with it. First note the mucous membrane stretching from the tongue to the gum of the lower jaw; then identify the various muscles.

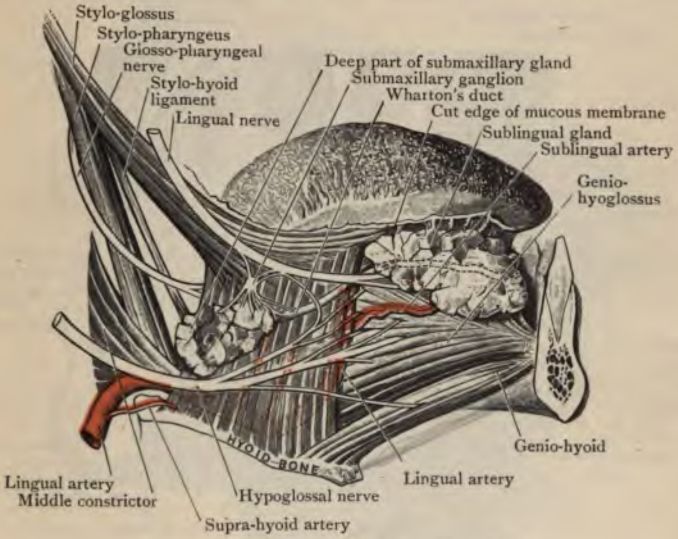

Stylo-glossus
Stylo-pharyngeus
Glosso-pharyngeal nerve
Stylo-hyoid ligament
Lingual nerve
Deep part of submaxillary gland
Submaxillary ganglion
Wharton's duct
Cut edge of mucous membrane
Sublingual gland
Sublingual artery
Genio-hyoglossus
Genio-hyoid
HYOID BONE
Lingual artery
Lingual artery
Middle constrictor
Hypoglossal nerve
Supra-hyoid artery

FIG. 112.—Dissection of Submaxillary Region.

The *hyoglossus*, a portion of which was previously visible behind the mylo-hyoid, is fully exposed. It is a quadrangular sheet of fleshy fibres which extends from the hyoid bone to the side of the tongue. Mark its position, because all the structures in this region have a more or less intimate relationship to it. Thus, behind, and to some extent superficial to its upper part, will be recognised the *stylo-glossus muscle*, whilst in front of it are the *genio-hyoglossus* and the *genio-hyoid.* The genio-hyoid muscle occupies the fore-part of the region, whilst the anterior part of the genio-hyoglossus is seen in the interval between it and the hyoglossus. Upon the surface of the hyoglossus, the lingual and hypoglossal nerves, the deep portion of the submaxillary gland with Wharton's duct, and the submaxillary ganglion are to be dissected. The *lingual nerve* occupies the highest level, and passes forward upon the muscle near its insertion into the tongue. The *hypoglossal nerve*, accompanied by the *ranine vein*, crosses it close to the hyoid bone, whilst *the deep part of the submaxillary gland* and *Wharton's duct* occupy an intermediate place. Although the *submaxillary ganglion* is very minute, its relations are so precise that it is very easily found. By seizing hold of the lingual nerve and dissecting carefully with the point of the knife in the interval between it and the deep part of the submaxillary gland, the ganglion will be exposed and its roots and branches of distribution made out. Upon the genio-hyoglossus, in front of the hyoglossus the dissector will note the *sublingual gland* with its artery of supply. Certain structures will also be seen passing under cover of the posterior margin of the hyoglossus muscle; these are:—

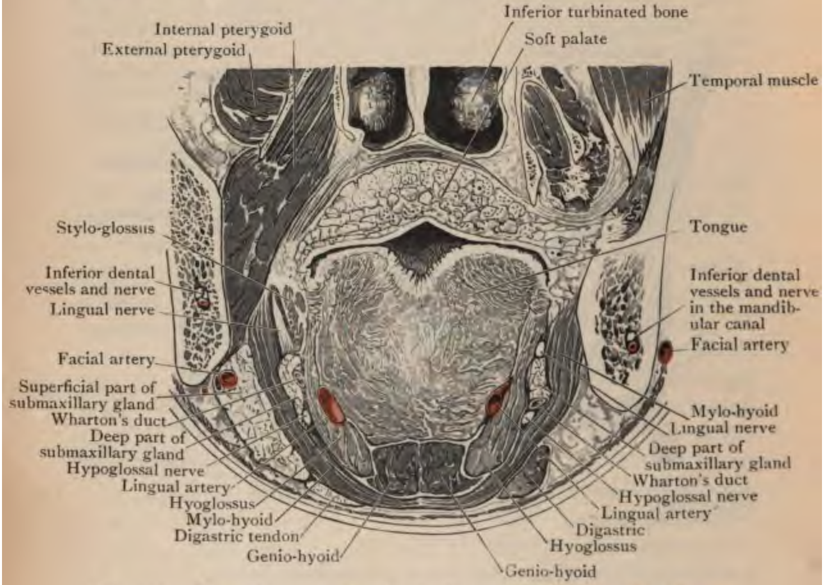

Inferior turbinated bone
Internal pterygoid
Soft palate
External pterygoid
Temporal muscle
Stylo-glossus
Tongue
Inferior dental vessels and nerve
Lingual nerve
Inferior dental vessels and nerve in the mandibular canal
Facial artery
Facial artery
Superficial part of submaxillary gland
Wharton's duct
Deep part of submaxillary gland
Hypoglossal nerve
Lingual artery
Hyoglossus
Mylo-hyoid
Digastric tendon
Genio-hyoid
Mylo-hyoid
Lingual nerve
Deep part of submaxillary gland
Wharton's duct
Hypoglossal nerve
Lingual artery
Digastric
Hyoglossus
Genio-hyoid

FIG. 113.—Coronal section through the Tongue and Submaxillary Region in a plane behind the molar teeth.

(1) the glosso-pharyngeal nerve immediately below the stylo-glossus muscle; (2) the stylo-hyoid ligament, a little lower down; and (3) the lingual artery, close to the hyoid bone.

Hyoglossus.—This is a quadrate flat muscle which arises from the whole length of the greater cornu, and also from the body of the hyoid bone. Its fibres pass upwards to the posterior part of the side of the tongue, where they ascend under cover of the stylo-glossus. The hyoglossus is supplied by the *hypoglossal nerve.*

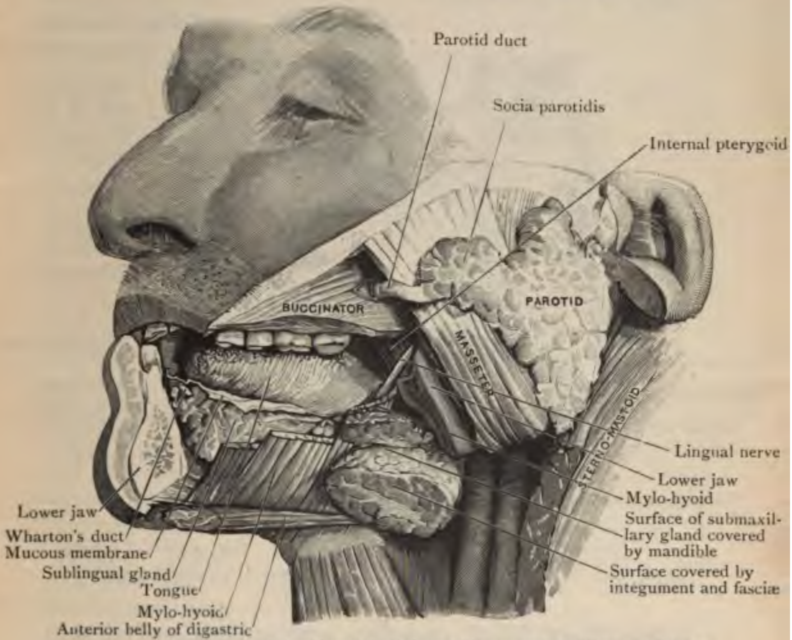

Parotid duct
Socia parotidis
Internal pterygoid
BUCCINATOR
PAROTID
MASSETER
STERNO-MASTOID
Lingual nerve
Lower jaw
Mylo-hyoid
Surface of submaxillary gland covered by mandible
Surface covered by integument and fasciæ
Lower jaw
Wharton's duct
Mucous membrane
Sublingual gland
Tongue
Mylo-hyoid
Anterior belly of digastric

FIG. 114.—Dissection of the Parotid, Submaxillary, and Sublingual Glands.

Stylo-glossus.—The stylo-glossus muscle is an elongated fleshy slip which takes origin from the anterior aspect of the styloid process near its tip and also to a slight extent from the upper end of the stylo-hyoid ligament. Passing downwards and forwards, its fibres may be traced upon the side of the tongue as far as the tip. They decussate with the fasciculi of the hyoglossus muscle. The nerve of supply to the stylo-glossus comes from the *hypoglossal.*

Genio-hyoid (musculus geniohyoideus).—The genio-hyoid muscle is placed close to the mesial plane, in contact with its fellow of the opposite side. It is a short muscle which arises from the lower of the two genial tubercles upon the posterior surface of the symphysis of the mandible, and extends downwards and backwards to gain insertion into the fore aspect of the body of the hyoid bone. The *hypoglossal* gives the nerve of supply to the genio-hyoid.

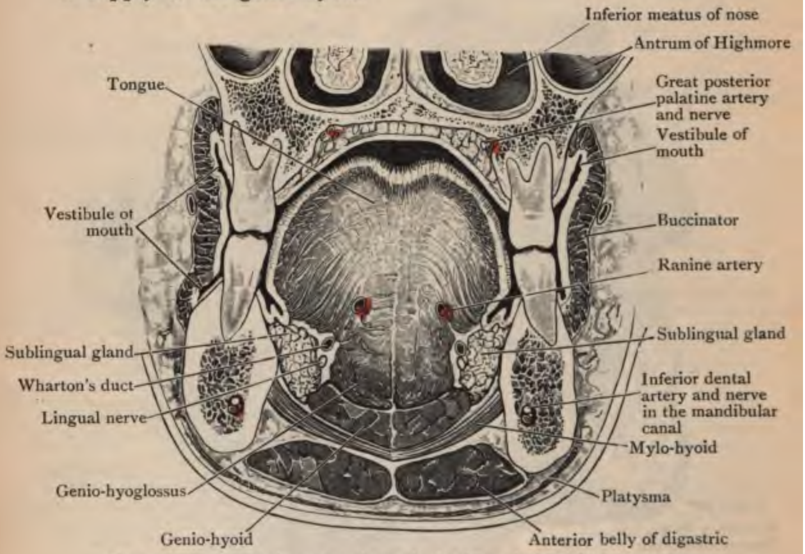

Inferior meatus of nose
Antrum of Highmore
Tongue
Great posterior palatine artery and nerve
Vestibule of mouth
Vestibule of mouth
Buccinator
Ranine artery
Sublingual gland
Sublingual gland
Wharton's duct
Lingual nerve
Inferior dental artery and nerve in the mandibular canal
Mylo-hyoid
Genio-hyoglossus
Platysma
Genio-hyoid
Anterior belly of digastric

FIG. 115.—Coronal section through the Closed Mouth in the plane of the second molar teeth.

Submaxillary Gland (glandula submaxillaris).—The submaxillary gland consists of a superficial and a deep portion; the *superficial* or *main part* has already been noted as the most conspicuous object in the digastric triangle. In size and shape it may be compared to a walnut, and it is contained within a capsule derived from the deep cervical fascia. Its *superficial surface* presents two areas, an upper and a lower. Of these *the upper* lies under shelter of the body of the lower jaw and looks upwards and outwards; *the lower*, which looks downwards and outwards, is covered by the skin, superficial fascia, platysma, deep fascia, and is crossed by the facial vein. The *deep surface* of the gland rests upon the mylo-hyoid, and behind this upon the hyoglossus and the posterior belly of the digastric with the stylo-hyoid. From this surface the *deep part* of the gland is prolonged forwards under cover of the mylo-hyoid muscle along with the duct. Lodged in a deep groove upon the posterior and upper aspects of the gland is the facial artery (Fig. 113).

Wharton's Duct (ductus submaxillaris).—The duct of the submaxillary gland is termed *Wharton's duct.* It emerges from the deep surface of the main part of the gland, and with the deep part of the gland it proceeds forwards upon the hyoglossus muscle between the lingual nerve which lies above it and the hypoglossal nerve which is placed below it. Reaching the surface of the genio-hyoglossus muscle, it inclines slightly upwards and is crossed by the lingual nerve. Here it passes under cover of the sublingual gland, and gains the floor of the mouth, where it opens by a small orifice placed on the summit of a papilla which lies close to the side of the frenum linguæ.

The wall of Wharton's duct is much thinner than that of the parotid duct. If a small opening be made in it, the dissector will experience little difficulty in passing a fine probe or bristle along it into the mouth.

Sublingual Gland (glandula sublingualis).—The sublingual gland lies on the floor of the mouth, and is the smallest of the three salivary glands. It has an elongated shape, and in length it measures about one inch and a half. Its relations are very definite. Its prominent *upper border* can be seen within the mouth, beneath the fore-part of the tongue, where it is covered by a fold of mucous membrane termed the plica sublingualis (Fig. 115). *Internally* it rests upon the genio-hyoglossus muscle, whilst *externally* it is lodged in a fossa on the deep aspect of the mandible, immediately external to the symphysis, and above the mylo-hyoid ridge. *Below*, it is supported by the mylo-hyoid muscle. Its anterior extremity reaches the mesial plane above the anterior border of the genio-hyoglossus and is in contact with its fellow of the opposite side. The duct of Wharton and the lingual nerve are prolonged forwards under cover of the sublingual gland.

Numerous small ducts (the number varying from eight to twenty) proceed from the sublingual gland. These are called the *ducts of Rivinus*, and they all, as a rule, open into the mouth on the summit of the plica sublingualis (Birmingham).

Lingual Nerve (nervus lingualis). — In the dissection of the pterygo-maxillary region, the lingual nerve has been seen passing downwards between the ramus of the mandible and the internal pterygoid muscle. It now inclines forwards to reach the side of the tongue, and, passing over the superior constrictor muscle of the pharynx, it lies below the last molar tooth between the mucous membrane and the body of the mandible. At this point it is in danger of being hurt by the clumsy extraction of one of the lower molars, and here also it may be divided by the surgeon, from the inside of the mouth. In its further course the nerve keeps close to the side of the tongue, crossing the upper part of the hyoglossus, and, beyond this, the duct of Wharton. It is placed immediately under the mucous membrane of the mouth, and it can be traced as far as the tip of the tongue.

The *branches* which proceed from the lingual nerve in this region are of two kinds—(1) twigs of communication; (2) branches of distribution.

Twigs of Communication.	1. Two or more to the submaxillary ganglion.
	2. One or two which descend along the anterior border of the hyoglossus muscle to unite with the hypoglossal nerve.
Branches of Distribution.	1. Slender filaments to the mucous membrane of the mouth and gums.
	2. A few twigs to the sublingual gland.
	3. Branches to the tongue.

The *lingual branches* pierce the substance of the tongue, and then incline upwards to supply the mucous membrane with the conical and fungiform papillæ over the anterior two-thirds of this organ.

Submaxillary Ganglion.—This is a minute ganglion which will be found lying upon the upper part of the hyoglossus muscle in the interval between the lingual nerve and the deep part of the submaxillary gland, under cover of the mylo-hyoid muscle. In size it is not larger than the head of a large pin, and, when freed from the connective tissue surrounding both it and its branches, it will be seen to be suspended from the lingual nerve by two short branches, which enter its upper border, and are separated by a distinct interval. Of these, the posterior connecting twig is frequently in the form of two or three filaments, which convey to the ganglion its sensory and secretory roots, whilst the anterior connecting branch must be looked upon as a twig given by the ganglion to the lingual nerve.

In common with the other ganglia developed in connexion with the branches of the fifth cranial nerve, this ganglion has three roots—viz., (1) a *sensory root* from the lingual nerve; (2) a *secretory root* from the chorda tympani; and (3) a *sympathetic root* from the plexus around the facial artery.

From its lower border several minute twigs proceed, and these are distributed—(1) to the submaxillary gland; (2) to Wharton's duct; (3) from the branch which it gives to the lingual nerve to the sublingual gland; and (4) to the mucous membrane of the mouth.

Hypoglossal Nerve (nervus hypoglossus).—This nerve has been traced in the dissection of the anterior triangle to the point where it disappears under cover of the mylo-hyoid muscle (p. 211). It is now seen passing forwards upon the hyoglossus muscle above the hyoid bone, and below the level of the deep part of the submaxillary gland. At the anterior border of the hyoglossus it gains the surface of the genio-hyoglossus muscle, into the substance of which it sinks, and finally breaks up into branches which supply the muscular substance of the tongue. Upon the hyoglossus muscle it is accompanied by one of the lingual veins, frequently termed the *ranine vein*.

The *branches* which spring from the hypoglossal nerve in this region are very numerous, and are entirely distributed to muscles. It supplies—(1) the stylo-glossus; (2) the hyoglossus; (3) the genio-hyoglossus; (4) the genio-hyoid; and (5) the intrinsic muscles of the tongue.

In addition, it communicates freely with the lingual nerve. The more apparent of these connexions take place in the form of one or more loops in relation to the anterior border of the hyoglossus. Other communications with the same nerve are effected in the substance of the tongue.

Reflection of the Hyoglossus.—The hyoglossus should now be carefully detached from the hyoid bone, and thrown upwards towards the tongue. In doing this there is no need to divide the structures which lie upon its surface. By the reflection of this muscle the following structures will be fully displayed—(1) the second and third stages of the lingual artery, with its dorsalis linguæ branch and the veins which accompany it; (2) the posterior part of the genio-hyoglossus; (3) the origin of the middle constrictor of the pharynx; and (4) the attachment of the stylo-hyoid ligament.

Genio-hyoglossus (musculus genio-glossus).—This is a flat triangular muscle, the inner surface of which is in contact in the mesial plane with its fellow of the opposite side. It arises by a short pointed tendon from the upper of the two genial tubercles which project from the posterior aspect of the symphysis of the mandible, and from this its fleshy fasciculi spread out in a fan-shaped manner. By far the greater part of the muscle is inserted into the tongue by an insertion which extends from the tip backwards throughout the whole length of the organ; below the tongue, a few fibres reach the side of the pharynx, whilst the remainder are inserted into the body of the hyoid bone. As we have already noted, the genio-hyoglossus is supplied by twigs from the *hypoglossal nerve.*

Lingual Artery (arteria lingualis).—As the lingual artery is now fully exposed, it can be conveniently studied at this stage. It springs from the fore-part of the external carotid, and it is customary to describe it in three parts—viz., (1) a part extending from its origin to the posterior border of the hyoglossus muscle; (2) a part lying in relation to the upper border of the hyoid bone; (3) a portion ascending under cover of the anterior border of the hyoglossus muscle to the under surface of the tongue, where it ends in a terminal branch called the *ranine artery* (Fig. 112).

The *first part* has been fully examined in a previous dissection. It lies in the carotid triangle of the neck, and is therefore comparatively superficial. It is crossed by the hypoglossal nerve, the tendon of the digastric and the stylo-hyoid muscle. The *second part* proceeds forwards along the upper border of the great cornu of the hyoid bone, and is covered by the hyoglossus muscle which intervenes between it and the hypoglossal nerve. The nerve, however, is placed at a slightly higher level. The deep or internal relations of the artery in this stage of its course are the middle constrictor of the pharynx and the genio-hyoglossus. The *third part* ascends almost vertically upon the genio-hyoglossus. It is overlapped by the anterior border of the hyoglossus, and ends when it reaches the under surface of the tongue by turning forwards into its terminal or *ranine* branch.

The *branches* of the lingual artery are:—

1. Suprahyoid from the *first* part (p. 237).
2. Dorsalis linguæ from the *second* part.
3. Sublingual from the *third* part.
4. The ranine or terminal branch.

The *dorsalis linguæ* is generally represented by two or more well-marked branches (rami dorsales linguæ) which pass upwards under cover of the hyoglossus muscle to end in twigs to the mucous membrane covering the back part of the dorsum of the tongue. Some twigs are also supplied to the muscular substance of the organ, and a few may be traced backwards into the tonsil.

The *sublingual artery* (arteria sublingualis) emerges from under cover of the anterior border of the hyoglossus, and then ascends upon the genio-hyoglossus to reach the sublingual gland which it supplies. It also gives branches to the surrounding muscles, and anastomoses with its fellow of the opposite side and with the submental branch of the facial artery.

The *ranine artery* (arteria profunda linguæ) runs forwards upon the inferior aspect of the tongue as far as the tip. It can easily be exposed by dividing the mucous membrane along its course, when it will be seen to lie close to the attachment of the frenum of the tongue, and to be continued forwards in the interval between the genio-hyoglossus and the inferior lingualis muscle. Its course is tortuous to allow of the protrusion or elongation of the organ, and it gives off numerous branches.

Lingual Veins.—The lingual artery is accompanied by two small venæ comites which lie with it under cover of the hyoglossus; but the main vein of the tongue, termed the *ranine*, accompanies the hypoglossal nerve upon the superficial surface of the hyoglossus muscle. These veins receive tributaries corresponding more or less closely with the branches of the artery, and they open into the common facial vein, or perhaps directly into the internal jugular vein.

Stylo-hyoid Ligament.—This is the last structure to be examined in this dissection. It is a fibrous cord which springs from the tip of the styloid process and passes downwards and forwards to be attached under cover of the hyoglossus muscle to the lesser cornu of the hyoid bone. It is not uncommon to find it partially ossified; in other cases it may assume a ruddy hue and contain muscular fibres.

DEEP DISSECTION OF THE NECK.

In the deep dissection of the neck the following structures are displayed:—

1. The styloid process, with the three muscles which take origin from it.
2. The internal carotid artery.
3. The ascending pharyngeal artery.
4. The tonsillitic and ascending palatine branches of the facial artery.
5. The internal jugular vein.
6. Glosso-pharyngeal nerve.
7. Vagus nerve.
8. Spinal accessory nerve.
9. Hypoglossal nerve.
10. The cervical part of the sympathetic cord.
11. The first loop of the cervical plexus.
12. The rectus lateralis muscle.

Dissection.—Before the dissection is commenced, the skull-cap, which, up to the present time, has been retained in position by the flaps of scalp stitched over it, should be removed. The floor of the cranium should then be cleansed by sponging it with spirit and carbolic solution. To expose the styloid process and its muscles, it is necessary to turn aside the posterior belly of the digastric, and the external carotid artery. Detach the former from its origin, and throw it downwards and forwards towards the hyoid bone. Its nerve of supply from the facial must also be cut; and if the filament which connects this branch with the glosso-pharyngeal nerve has not been previously seen, it should now be sought for. The external carotid artery may be divided immediately below the point where it divides into its two terminal branches. After cutting the occipital and posterior auricular arteries, it can be turned forwards out of the way.

Of the parts in connexion with the styloid process, the stylo-hyoid and stylo-glossus muscles and the stylo-hyoid ligament have been already fully examined; the stylo-pharyngeus muscle alone remains to be described. In cleaning the fibres of this muscle, be careful not to injure the glosso-pharyngeal nerve which appears at its lower border, and gives to it its nerve of supply.

Stylo-pharyngeus.—This is the longest of the three slender muscles which spring from the styloid process. It arises from its deep or inner surface close to its root, and extends downwards and forwards to gain the side of the pharynx. Here it disappears under cover of the upper border of the middle constrictor muscle, and its fibres spread out, to be inserted for the most part into the upper and hinder borders of the thyroid cartilage; a certain proportion, however, are lost in the wall of the pharynx. The stylo-pharyngeus muscle is supplied by a branch from the *glosso-pharyngeal nerve.*

Dissection.—Snip through the base of the styloid process with the bone pliers, and throw it and its attached muscles downwards and forwards. The *internal carotid* and *ascending pharyngeal arteries* may now be followed up to the base of the skull. The *glosso-pharyngeal, vagus, spinal accessory*, and *hypoglossal nerves*, and the *superior cervical ganglion*, with their various connexions and branches, must at the same time be dissected. This is an exceedingly difficult dissection. A dense and tough fascia envelops these structures, and a great amount of patience is required to trace the branches of the nerves through it. One nerve—*the pharyngeal branch of the vagus*—which proceeds downwards and forwards upon the superficial or outer aspect of the internal carotid, is especially liable to injury, and must therefore be borne in mind from the very outset of the dissection. The *internal laryngeal* and the *external laryngeal nerves* have been previously displayed in the anterior triangle of the neck. These, if traced upwards, will lead to the *superior laryngeal branch* of the vagus, which is carried downwards upon the deep aspect of the internal carotid artery. At the base of the skull all the nerve-trunks will be found making their appearance close together in the interval between the internal jugular vein and the internal carotid artery; whilst behind the vein the *rectus lateralis muscle* and the *first loop* of the *cervical plexus* will be seen.

Internal Carotid Artery (arteria carotis interna).—The internal carotid artery is one of the two terminal branches of the common carotid, and commences at the level of the upper border of the thyroid cartilage. From this point it proceeds upwards in the neck in a vertical direction, until it reaches the base of the skull; here it disappears from view by entering the carotid canal of the petrous portion of the temporal bone, through which it reaches the interior of the cranium. The internal carotid artery can therefore be very appropriately divided into three parts—viz., (1) a cervical; (2) a petrous; and (3) an intracranial. The cervical part alone comes under the notice of the student in the present dissection.

In the first instance, the internal carotid artery is placed within the carotid triangle, and is therefore comparatively superficial. It is covered by the integument, platysma, and fascia, and is overlapped by the sterno-mastoid muscle. As it proceeds upwards, it gradually sinks deeply, until it comes to lie under cover of the entire mass of the parotid gland, the styloid process, the stylo-pharyngeus muscle, the stylo-hyoid muscle, and the posterior belly of the digastric. *Three nerves* and *two arteries* will also be noticed to cross the vessel superficially, viz.:—

1. The hypoglossal nerve.
2. The glosso-pharyngeal nerve.
3. The pharyngeal branch of the vagus nerve.

1. The occipital artery.
2. The posterior auricular artery.

The relationship of the external carotid artery to the internal carotid is a varying one. At first the external carotid lies in front of it; but soon, owing to its inclination backwards, it comes to lie directly superficial to the internal

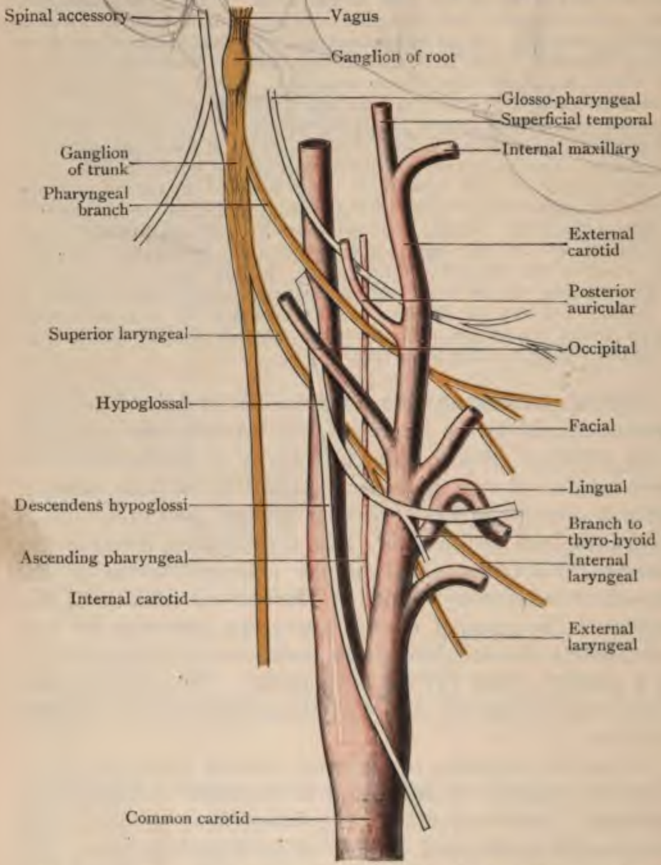

Spinal accessory
Vagus
Ganglion of root
Glosso-pharyngeal
Superficial temporal
Ganglion of trunk
Internal maxillary
Pharyngeal branch
External carotid
Posterior auricular
Superior laryngeal
Occipital
Hypoglossal
Facial
Lingual
Descendens hypoglossi
Branch to thyro-hyoid
Ascending pharyngeal
Internal laryngeal
Internal carotid
External laryngeal
Common carotid

FIG. 116.—Diagram of Carotid System of Vessels in the Neck with the Glosso-pharyngeal, Vagus, Spinal Accessory, and Hypoglossal Nerves.

carotid. The following structures intervene between the two vessels:—

1. Styloid process.
2. Stylo-pharyngeus muscle.
3. Glosso-pharyngeal nerve.
4. Pharyngeal branch of vagus.
5. A portion of the parotid gland.

Behind, the internal carotid rests upon the rectus capitis anticus major muscle, and is in contact with the vagus nerve and the superior cervical ganglion of the sympathetic. To its *outer side* is the internal jugular vein. A prolongation upwards of the carotid sheath encloses the two vessels together with the vagus nerve. On its *inner aspect* the internal carotid is related to the pharynx and the ascending pharyngeal artery.

Before leaving this vessel, note that at the base of the skull four nerves appear in the interval between it and the internal jugular vein; these are the glosso-pharyngeal, the vagus, the spinal accessory, and the hypoglossal.

Ascending Pharyngeal Artery (arteria pharyngea ascendens).—The origin of this vessel from the external carotid has already been observed (p. 239). It proceeds vertically upwards to the base of the skull, where it ends by dividing into minute meningeal twigs. Its relations are very simple. It is placed between the internal carotid artery and the wall of the pharynx, and this position it holds throughout its entire course.

The following branches will be recognised as springing from the ascending pharyngeal:—

1. Pharyngeal.
2. Prevertebral.
3. Meningeal.

The *pharyngeal branches* (rami pharyngei) supply the pharynx, and the lower members of the series anastomose with the superior thyroid artery. Higher up, a larger *palatine branch* distributes twigs to the Eustachian tube, the soft palate, and the tonsil.

The *prevertebral branches* are small twigs which are given to the prevertebral muscles, and anastomose with the ascending cervical artery.

The *meningeal twigs* enter the cranium through three openings, viz., the foramen lacerum medium, the jugular foramen, and the anterior condyloid foramen.

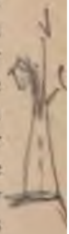
Inferior Palatine and Tonsillitic Arteries.—At this stage the dissector should again examine these vessels—the first branches which are given off by the facial artery. They have already been described (p. 237), but their relations as they ascend in the neck can now be more satisfactorily studied. The size of the *inferior* or *ascending palatine* is very variable, and depends very much upon that of the *palatine branch* of the ascending pharyngeal.

Internal Jugular Vein (vena jugularis interna). — The internal jugular vein is the largest venous channel of the neck. It is directly continuous with the lateral sinus of the cranial cavity, and it enters the neck through the posterior compartment of the jugular foramen. From this it proceeds downwards, until it reaches the posterior aspect of the inner end of the clavicle, where it joins the subclavian vein to form the innominate or brachio-cephalic vein. Its commencement in the jugular foramen shows a slight dilatation, termed *the bulb*, the lumen of which remains at all times patent owing to the connexion of its walls to the margins of the foramen. By passing a probe from the lateral sinus into the internal jugular vein, the continuity of the two channels can be easily demonstrated.

The relations which the internal jugular vein presents in the neck can be summed up in a very few words. At the base of the skull it lies behind the internal carotid artery, and rests upon the rectus lateralis muscle. Very soon, however, it changes its relationship to the internal carotid, and comes to lie upon its outer side. This position it maintains until it reaches the upper border of the thyroid cartilage. Below this level it is continued downwards upon the outer side of the common carotid artery.

Throughout its whole length it is included within a sheath of fascia common to it, the two arteries along which it lies, and the vagus nerve. Lastly, at the root of the neck, its terminal part crosses the first portion of the subclavian artery.

But there are some slight differences to be noted between the two veins of opposite sides. The *right vein* is usually considerably the larger of the two, and as they approach the root of the neck both veins incline slightly to the right. From this it follows that the *left vein* is closely applied to the lower portion of the common carotid artery of that side, whilst the *right vein* is separated from its companion artery by a narrow interval which presents a triangular figure. The base of this triangle is formed by the first part of the subclavian artery,



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and it is bisected by the vagus nerve. It should also be remembered that on the *left side* the terminal part of the thoracic duct passes behind the internal jugular vein.

The tributaries which join the internal jugular vein have for the most part been previously studied. They are :—

1. Inferior petrosal sinus (p. 129).
2. Pharyngeal veins.
3. Lingual veins (p. 305).
4. Common facial vein (p. 238).
5. Superior thyroid vein (p. 236).
6. Middle thyroid vein (p. 242).
7. Thoracic duct on the left side and the right lymphatic duct on the right side (p. 224).

The *inferior petrosal sinus* leaves the cranial cavity by the anterior compartment of the jugular foramen, and joins the fore-part of the internal jugular vein close to the base of the skull. By passing a probe from the interior of the skull through the sinus, its connexion with the vein can readily be made out.

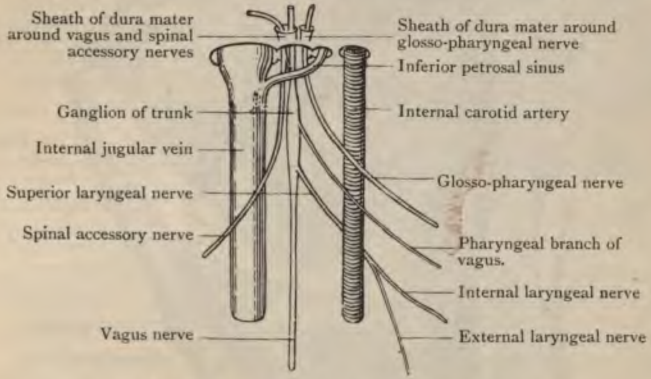

Sheath of dura mater around vagus and spinal accessory nerves
Ganglion of trunk
Internal jugular vein
Superior laryngeal nerve
Spinal accessory nerve
Vagus nerve
Sheath of dura mater around glosso-pharyngeal nerve
Inferior petrosal sinus
Internal carotid artery
Glosso-pharyngeal nerve
Pharyngeal branch of vagus.
Internal laryngeal nerve
External laryngeal nerve

FIG. 117.—Diagram of the relation of parts in the Jugular Foramen.

The *pharyngeal tributaries* join the internal jugular about the level of the hyoid bone. They come from a venous plexus which lies upon the side of the pharynx, and presents free communications above with the pterygoid plexus.

Dissection.—The internal jugular vein should now be slit open. A short distance above its termination a single or a double flapped valve will be discovered. The vein should then be divided about two inches below its commencement and its upper part thrown upwards. This is done to enable the dissector to obtain a better view of the hypoglossal nerve as it issues from the anterior condyloid foramen.

Glosso-pharyngeal, Vagus or Pneumogastric, and Spinal Accessory Nerves.—These nerves have, on a previous occasion, been seen leaving the cranial cavity through the middle compartment of the jugular fossa, in the interval between the commencement of the internal jugular vein behind and the inferior petrosal sinus in front (p. 126, and Fig. 60, p. 125). It is well that the dissector should again examine the interior of the cranial cavity and refresh his memory as to the manner in which they enter the foramen. The *glosso-pharyngeal* occupies the foremost position, and it is cut off from the others by possessing a special and separate tube-like sheath of dura mater. The *spinal accessory* is placed behind the *vagus*, and both are included within the same sheath of dura mater. They therefore traverse the foramen in close contact with each other. Reaching the exterior of the skull, the three nerves at first lie, together with the hypoglossal nerve, in the interval between the internal jugular vein and the internal carotid artery, but soon they choose different

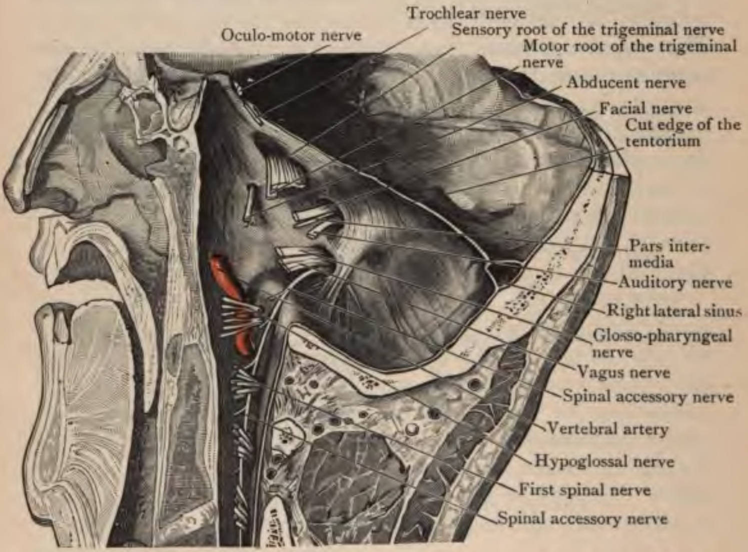

Trochlear nerve
Oculo-motor nerve
Sensory root of the trigeminal nerve
Motor root of the trigeminal nerve
Abducent nerve
Facial nerve
Cut edge of the tentorium
Pars intermedia
Auditory nerve
Right lateral sinus
Glosso-pharyngeal nerve
Vagus nerve
Spinal accessory nerve
Vertebral artery
Hypoglossal nerve
First spinal nerve
Spinal accessory nerve

FIG. 118.—Section through the Head a little to the right of the Mesial Plane. It shows the posterior cranial fossa and the upper part of spinal canal after the removal of the brain and the cord.

routes. The *spinal accessory* inclines backwards over or behind the internal jugular vein; the *glosso-pharyngeal* inclines forwards over the internal carotid; whilst the *vagus* proceeds vertically downwards between these vessels (Fig. 117).

In an ordinary dissection it is impossible to follow out many of the minute twigs which take origin from these nerves in the region of the basis cranii. To do so it is necessary to possess a perfectly fresh part, which has been specially prepared by having the soft parts toughened with spirit and the bone softened by immersion in a weak solution of acid. Even then the dissection is a difficult one, although it should certainly be undertaken by the advanced student in the event of his being able to obtain a part for the purpose.

In the following description of these nerves the account of the branches which can in all cases be traced is printed in *large type*, whilst that of those requiring special dissection is printed in *small type.*

Glosso-pharyngeal Nerve (nervus glosso-pharyngeus).—The glosso-pharyngeal nerve inclines downwards and forwards and crosses the internal carotid artery superficially. It passes under cover of the styloid process and the stylo-pharyngeus muscle, and at the lower border of the latter it hooks round the muscle and then curves forwards upon its superficial surface to gain the base of the tongue. In the dissection of the submaxillary region, its terminal part has been seen disappearing under cover of the posterior border of the hyoglossus muscle; here it ends in *lingual branches.*

In the present dissection the following branches should be made out:—

1. Communicating branch from the facial.
2. Nerve to the stylo-pharyngeus.
3. Pharyngeal.
4. Tonsillitic.
5. Lingual.

The *communicating branch from the facial* springs from the nerve to the posterior belly of the digastric, and, as a rule, emerges from midst the fibres of this muscle to join the glosso-pharyngeal close to the lower part of the jugular foramen.

The *stylo-pharyngeal nerve* is a small twig which enters the muscle of the same name. The greater part of its fibres, however, are continued through the muscle to the mucous membrane of the pharynx.

The *pharyngeal branches* consist—(1) of one or two small twigs which perforate the superior constrictor to reach the mucous membrane of the pharynx; and (2) a larger nerve which comes off higher up and joins the pharyngeal branch of the vagus to form the pharyngeal plexus. It frequently divides into two or more branches.

The *tonsillitic branches* proceed from the glosso-pharyngeal near the base of the tongue. They form a plexus over the tonsil, termed the *circulus tonsillaris*, and give twigs to the mucous membrane of the isthmus faucium and the soft palate.

The *terminal* or *lingual branches* will be followed in the dissection of the tongue.

There are still other points in connexion with the glosso-pharyngeal nerve which require mention. At the lower part of the jugular foramen two small ganglia are formed upon its trunk, and from the lower of these certain minute branches are given off. The upper ganglion is called the *jugular ganglion*; the lower one is termed the *petrous ganglion*.

The *jugular ganglion* is a minute ganglionic swelling, which only involves a portion of the fibres of the nerve-trunk, and is placed in the upper part of the bony groove in which the nerve lies as it proceeds through the jugular foramen. No branches arise from it.

The *petrous ganglion* is a larger swelling, which involves the entire nerve-trunk, and lies at the opening of the jugular foramen between the inferior petrosal sinus (which intervenes between it and the anterior border of the foramen) and the vagus nerve invested by its fibrous sheath derived from the dura mater. Its length is not more than two or three lines. Three branches of communication enter or proceed from it. These connect it with—(1) the superior cervical sympathetic ganglion; (2) the auricular branch of the vagus; and (3) the root-ganglion of the vagus.

In addition to these twigs the *tympanic nerve* or the *nerve of Jacobson* takes origin from the petrous ganglion.

Tympanic Nerve.—The ultimate destination of this nerve may be regarded as being the otic ganglion, but it takes a very circuitous route to gain this structure. It enters a small foramen on the ridge which separates the jugular fossa from the carotid foramen on the under surface of the petrous bone, and it is conducted by a narrow canal to the tympanic cavity. It traverses the inner wall of this chamber, grooving the promontory. Having gained the anterior part of the tympanum, it enters the bone a second time, and runs in a minute canal, which tunnels the petrous bone below the upper end of the channel in which is lodged the tensor tympani muscle. In this part of its course the tympanic nerve is joined by a branch from the geniculate ganglion of the facial nerve, and, after the junction is effected, it is termed the *small superficial petrosal nerve*.

The canal in which the *small superficial petrosal nerve* is lodged opens into the cranial cavity upon the anterior face of the petrous bone, immediately external to the hiatus Fallopii. Through this the nerve emerges, and soon leaves the interior of the cranium by passing downwards in the interval between the great wing of the sphenoid and the petrous bone. Outside the skull it ends by joining the otic ganglion.

In the tympanic cavity the *tympanic nerve* gives branches of supply —(1) to the mucous membrane of the tympanum; (2) to the lining membrane of the mastoid cells; and (3) to the mucous membrane of the Eustachian tube. It also gives off a fine branch termed the *small deep eptrosal nerve* (n. petrosus profundus minor). This enters a canal in the processus cochleariformis which conducts it to the foramen lacerum medium, where it effects a junction with the carotid plexus. The tympanic nerve likewise receives a minute twig from the carotid plexus which is called the *nervus carotico-tympanicus.*

Vagus or Pneumogastric Nerve.—The vagus passes through the middle compartment of the jugular foramen in company with the spinal accessory—both being included within the same sheath of dura mater. In the neck it pursues a vertical course, lying, in the first instance, between the internal jugular vein and the internal carotid artery, and afterwards between the same vein and the common carotid artery. Further, as has been already observed, it is enclosed within the sheath which envelops these vessels, and it lies upon a plane posterior to them. At the root of the neck it enters the thorax, and shows different relations on the two sides. On the *right side* it crosses the first part of the subclavian artery; on the *left side* it proceeds downwards between the common carotid and left subclavian arteries, and passes under cover of the left innominate vein.

As in the case of the glosso-pharyngeal, the vagus shows two ganglia in connexion with its upper part. These are the *ganglion of the root* (*ganglion jugulare*) and the *ganglion of the trunk* (*ganglion nodosum*).

The **Ganglion of the Root** is situated within the jugular foramen. It is a rounded swelling which is connected by communicating twigs with several of the nerves in the neighbourhood, and which gives off two branches of distribution.

BRANCHES OF COMMUNICATION.	BRANCHES OF DISTRIBUTION.
1. With the facial nerve. 2. With the petrous ganglion of the glosso-pharyngeal. 3. With the spinal accessory. 4. With the superior ganglion of the sympathetic.	1. Recurrent nerve. 2. Auricular nerve.

The *recurrent branch* is a minute twig which runs backwards through the jugular foramen, and, dividing into two branches, is distributed to the dura mater in the posterior cranial fossa.

The *auricular nerve* (Arnold's nerve) obtains a filament of communication from the petrous ganglion of the glosso-pharyngeal, and proceeds backwards upon the outer surface of the bulb of the internal jugular vein to enter a minute aperture on the posterior part of the outer wall of the jugular foramen. A narrow canal now conducts it through the substance of the temporal bone, and, on its way, it crosses internal to the Fallopian canal a short distance above the stylo-mastoid foramen. It is thus brought into close relation with the facial nerve, and is connected with it by an ascending and a descending branch of communication. Finally, it appears on the surface of the skull in the interval between the mastoid process and the external auditory meatus. Its further course is described on p. 262.

Ganglion of the Trunk.—After emerging from the jugular foramen, the vagus nerve is joined by the *accessory portion* of the *spinal accessory nerve*, and swells out into the ganglion of the trunk.

The *ganglion of the trunk* is an elongated reddish-coloured swelling of about three-quarters of an inch in length, which is developed upon the stem of the vagus nerve half an inch below the base of the cranium. Strong branches of communication pass between this ganglion, the first loop of the cervical plexus, and the superior cervical ganglion of the sympathetic. Further, the hypoglossal nerve is generally closely bound to it by fibrous attachment, in the midst of which some interchange of nerve filaments takes place.

Branches of Distribution of the Cervical Part of the Vagus.—The branches which spring from the vagus as it traverses the neck are the following:—

1. Pharyngeal.
2. Superior laryngeal.
3. Inferior or recurrent laryngeal.
4. Cardiac.

Pharyngeal Branch (ramus pharyngeus).—This springs from the upper part of the ganglion of the trunk, and runs downwards and forwards, superficial to the internal carotid artery, to end in the *pharyngeal plexus*. Very frequently it is replaced by two branches, of which the upper is the larger.

Superior Laryngeal Nerve (nervus laryngeus superior).—This is a much larger branch, which takes origin from the middle of the same ganglion. It passes downwards and forwards, but differs from the preceding nerve by passing *under cover of* the internal carotid artery. In this situation it ends by dividing into the *internal laryngeal* and *external laryngeal nerves*; both of these have been previously seen in the dissection of the anterior triangle (p. 203). Before it divides, the superior laryngeal effects communications by means of fine twigs with the superior cervical ganglion of the sympathetic, and it also receives one or two filaments from the pharyngeal plexus.

The *internal laryngeal nerve* runs forwards to the interval between the hyoid bone and the thyroid cartilage, and, disappearing under cover of the posterior border of the thyrohyoid muscle, it pierces the membrane of the same name, and enters the larynx.

The *external laryngeal nerve* is a very slender branch, which inclines downwards and forwards to reach the crico-thyroid muscle in which it ends. It supplies a few filaments to the inferior constrictor of the pharynx and a fine twig to the superior cardiac branch of the sympathetic, whilst it receives a communicating branch from the superior cervical ganglion of the sympathetic.

Recurrent Laryngeal Nerve (nervus laryngeus inferior).—The recurrent laryngeal arises differently on the two sides. On the *right side*, it springs from the vagus as it crosses the first part of the subclavian artery, and it adopts its recurrent course by hooking round this vessel. On the *left side*, it arises in the thorax, and hooks round the aortic arch (or, more correctly speaking, around the termination of the obliterated ductus arteriosus). In the neck each nerve ascends in the groove between the trachea and œsophagus, and passing behind or in front of the inferior thyroid artery, or it may be between the two terminal branches of this artery, it disappears under cover of the lower border of the inferior constrictor muscle, to enter the larynx.

Before the recurrent laryngeal nerve reaches the larynx it gives off several branches—viz., (1) cardiac branches; (2) twigs to the trachea and œsophagus; and (3) a few filaments to the inferior constrictor as it passes under cover of its lower margin.

Cardiac Branches.—Two cardiac branches arise from the vagus in the neck. On the *right side*, both of these enter the thorax by passing behind the subclavian artery and end in the deep cardiac plexus. On the *left side*, the *upper nerve* joins the deep cardiac plexus, whilst the *lower nerve* enters into the formation of the superficial cardiac plexus.

Spinal Accessory Nerve (nervus accessorius).—This nerve consists of two parts—an *accessory* and a *spinal*. In the foramen jugulare the *accessory portion* is connected by one or two fine twigs with the root-ganglion of the vagus, and below the basis cranii it leaves the spinal part and joins the vagus.

The accessory part of the spinal accessory nerve contributes to the vagus the greater proportion of its motor fibres. They pass over the surface of the trunk-ganglion, and are continued into the pharyngeal and into the superior laryngeal nerves. Some of the fibres are likewise carried down the stem of the vagus into the cardiac branches and also into the recurrent laryngeal nerve.

The *spinal part* of the spinal accessory is directed backwards under the transverse process of the atlas. It crosses the internal jugular vein, and disappears into the substance of the sterno-mastoid muscle. Its further course has been already studied (pp. 137 and 203). It is distributed to two muscles—viz., the sterno-mastoid and the trapezius.

Pharyngeal Plexus (plexus pharyngeus).—This is a meshwork of fine nerve filaments, which is formed upon the lateral wall of the pharynx at the level of the middle constrictor muscle. The pharyngeal branches of the vagus, glossopharyngeal, and superior cervical ganglion of the sympathetic enter into its construction, and one or more minute ganglia are developed in connexion with it. Its terminal twigs are given to the muscles and mucous membrane of the pharynx, and one branch (the *ramus lingualis vagi*) connects the plexus with the hypoglossal nerve.

Hypoglossal Nerve (nervus hypoglossus).—The hypoglossal nerve makes its exit from the cranium, through the anterior condyloid foramen. It pierces the dura mater in two separate parts, which unite into one stem at the entrance of the bony foramen. As it issues from the anterior condyloid foramen it lies deeply under cover of the internal jugular vein and the internal carotid artery; but it almost immediately inclines outwards, and, taking a half spiral turn around the trunk-ganglion of the vagus, it appears between the two vessels, and is continued downwards and forwards. Its close connexion with the ganglion of the trunk of the vagus has already been noted. The two nerves at this point are almost inseparably united by dense connective tissue, and in the midst of this an interchange of nerve fibres takes place. Gaining the lower border of the posterior belly of the digastric muscle, the hypoglossal nerve hooks round the occipital artery, and enters the anterior triangle of the neck. From this point to the under surface of the tongue it has already been traced.

Branches of communication.—Near the base of the skull the hypoglossal is brought into connexion with (1) the superior ervical ganglion; (2) the vagus; and (3) the first cervical nerve. Further, as it turns round the occipital artery it receives the *ramus lingualis vagi* from the pharyngeal plexus.

The importance of the connexion between the hypoglossal and the first cervical nerve has already been referred to (p. 227, Fig. 87).

Branches of distribution.—With the exception of the minute recurrent and vascular twigs, which come off within the condyloid foramen, the branches of distribution which proceed from the hypoglossal nerve have been described (pp. 211 and 303).

The *recurrent branch* arises in the upper part of the anterior condyloid foramen, and, regaining the interior of the cranium, it is distributed to the dura mater around the foramen magnum.

The *vascular twigs* are some fine filaments, which are said to be supplied to the deep aspect of the internal jugular vein.

Dissection.—In the dissection of the neck the greater part of the cervical sympathetic, with the branches which proceed from it, has been displayed. The inferior ganglion, which lies deeply in the hollow between the transverse process of the seventh cervical vertebra and the neck of the first rib, is still to a certain extent concealed, and must now be displayed. Dislodge the subclavian artery from its place on the first rib behind the scalenus anticus muscle, and turn it well inwards. To do this efficiently, it will be necessary to cut the superior intercostal artery at its origin ; this vessel runs downwards upon the outer side of the sympathetic. Great care must be taken to preserve uninjured the fine nerves which proceed downwards in front of the first part of the subclavian artery. If more space for the dissection is required, the fore-part of the first rib may be removed by the bone-pliers, but, as a general rule, this will not be found to be necessary.

Sympathetic Cord in the Neck.—The number of ganglia which are developed upon the sympathetic cord in the neck is reduced to *three*, and no *white rami communicantes* enter either the cord or the ganglia from the cervical spinal nerves.

The sympathetic cord takes a vertical course through the neck in front of the roots of the transverse processes of the vertebræ. It lies upon the rectus capitis anticus major and the longus colli muscles, and is embedded in the posterior wall of the carotid sheath. *Above*, it is prolonged upwards in the form of a stout, ascending nerve-trunk, which accompanies the internal carotid artery into the carotid canal ; *below*, it becomes continuous over the neck of the first rib and behind the subclavian artery with the thoracic portion of the sympathetic. The branches take origin from the ganglia ; occasionally, however, one or more may be observed to arise from the connecting cords.

Superior Cervical Ganglion (ganglion cervicale superius).—

This is the largest of the three ganglia. It is an elongated fusiform body which varies somewhat in size. It is placed upon the upper part of the rectus capitis anticus major, opposite the second and third vertebræ, and behind the internal carotid artery. From its upper end the stout branch proceeds which enters the carotid canal, whilst its lower end tapers into the downward continuation of the cord. Numerous branches issue from it; of these some connect it with neighbouring nerves, whilst others are distributed in various ways.

The connecting branches are:—(1) slender *grey rami communicantes* which connect it with the upper four cervical nerves; (2) twigs to both ganglia of the vagus; (3) to the petrous ganglion of the glosso-pharyngeal; and (4) to the hypoglossal. It is not connected with the spinal accessory.

The branches of distribution are:—

1. Rami vasculares.
2. Pharyngeal.
3. Superior cardiac.

The *rami vasculares* (nervi carotici externi) are soft delicate filaments which run towards the external carotid artery, and form a loose interlacement around it and its branches. From this plexus a branch is given to the carotid body; further, the part continued upon the facial artery supplies, as we have already noted, the sympathetic root to the submaxillary ganglion, whilst the subdivision upon the middle meningeal artery furnishes the corresponding root to the otic ganglion, as well as the *external superficial petrosal nerve* which runs to the geniculate ganglion of the facial nerve.

The *pharyngeal branches* course inwards between the two carotid arteries to join the pharyngeal plexus.

The *superior cardiac nerve* (nervus cardiacus superior) is a long slender branch which springs by several roots from the ganglion and then proceeds downwards behind the carotid artery. At different stages of its course it is joined by other branches of the sympathetic, by a branch from the vagus, and also by filaments from the external laryngeal and recurrent laryngeal nerves. The *right superior cardiac nerve* is continued into the thorax by passing behind or in front of the subclavian artery, and it ends in the deep cardiac plexus. The *left superior cardiac nerve* follows the left common carotid artery in the thorax, and, crossing the arch of the aorta, ends in the superficial cardiac plexus.

Middle Cervical Ganglion (ganglion cervicale medium).—This ganglion is the smallest of the three ganglia of the neck. It is placed opposite the sixth cervical vertebra in close proximity to the inferior thyroid artery, upon which, indeed, it not infrequently rests. It presents the following branches:—

1. Grey rami communicantes which connect it with the *fifth* and *sixth spinal nerves*, and which pass between the contiguous margins of the scalenus anticus and longus colli muscles.
2. Thyroid branches which run to the thyroid body along the inferior thyroid artery, and which form connexions with the external and recurrent larnygeal nerves.
3. The middle cardiac nerve.

On both sides *the middle cardiac nerve* (nervus cardiacus medius) enters the thorax and is lost in the deep cardiac plexus. On the *right side* it passes behind or in front of the subclavian artery; on the *left side* it is continued downwards between the common carotid and subclavian arteries.

Inferior Cervical Ganglion (ganglion cervicale inferius).—This ganglion is lodged in the interval between the transverse process of the seventh cervical vertebra and the neck of the first rib. In this position it lies behind the vertebral artery. It is by no means uncommon to find it more or less completely fused over the neck of the first rib with the first thoracic ganglion. Again, the connexion between it and the middle ganglion is generally in the form of two or more slender nerve cords, of which one passes in front of the subclavian artery. The loop which is thus formed is termed the *ansa Vieussenii* (ansa subclavia).

The branches of the inferior cervical ganglion are:—

1. Grey rami communicantes to the seventh and eighth cervical nerves.
2. Rami vasculares.
3. Inferior cardiac nerve.

The *rami vasculares* are fine branches which form a plexus around the subclavian artery and its branches. Others, remarkable for their large size, join the vertebral artery.

The *lower cardiac nerve* (nervus cardiacus inferior) on both sides enters the deep cardiac plexus.

Dissection.—The little muscle termed the rectus capitis lateralis should now be cleaned, and its attachments defined. It lies in the interval between the transverse process of the atlas and the occiput, behind the commencement of the internal jugular vein. The anterior division of the first cervical nerve will be seen emerging from under cover of its inner margin.

Rectus Capitis Lateralis.—The rectus lateralis arises from the fore-part of the upper surface of the extremity of the transverse process of the atlas, and is inserted into the under surface of the jugular eminence of the occipital bone. It is supplied by a branch from the anterior division of the first cervical nerve.

First Loop of the Cervical Plexus.—The anterior primary division of the first cervical or suboccipital nerve may next be examined. It will be noticed emerging from under cover of the inner surface of the rectus lateralis muscle. It at once turns downwards in front of the transverse process of the atlas, and, joining the ascending branch of the second cervical nerve, forms the first loop of the cervical plexus. From this loop branches are given to two muscles—viz., the rectus capitis anticus major and minor. It is likewise brought into connexion by means of communicating twigs with—(1) the superior cervical ganglion; (2) the vagus; (3) the hypoglossal.

If the rectus lateralis muscle be detached from the transverse process of the atlas and turned upwards, a twig from the anterior division of the first cervical nerve will be found entering its deep surface; further, by cutting through the origin of the superior oblique muscle of the head, this nerve-division may be traced to the upper surface of the neural arch of the atlas, where it takes origin from the first spinal nerve-trunk (suboccipital nerve).

The entire length of the anterior primary division of the first cervical nerve may now be studied. It turns round the superior articular process of the atlas, under cover of the vertebral artery and the rectus capitis lateralis, and, gaining the anterior aspect of the atlas, it enters into the formation of the first loop of the cervical plexus. As it lies in relation to the vertebral artery, it is joined by a filament from the sympathetic plexus which surrounds that vessel.

Removal of the Head and Neck from the Trunk.—By the time that the dissectors of the head and neck have arrived at this stage of their work, the dissectors of the thorax have in all probability finished their dissection. If this be the case, the head and neck may be removed from the trunk by cutting through the vertebral column at the level of the intervertebral disc between the third and fourth dorsal vertebræ. By this proceeding the three upper dorsal vertebræ, with the attached portions of the first, second, and third pairs of ribs, are removed with the neck. The scalene muscles and the longus colli are therefore preserved intact.

THE LATERAL PART OF THE MIDDLE CRANIAL FOSSA.

The structures contained within the middle cranial fossa may now be examined, and, in carrying out this dissection, the head should be supported on a block so that the floor of the cranial cavity looks upwards. The following are the structures which must be displayed:—

1. Cavernous venous sinus.
2. Internal carotid artery.
3. Middle meningeal artery.
4. Small meningeal artery.
5. The two roots of the trigeminal nerve, with the Gasserian ganglion and the three main divisions of the trigeminal nerve.
6. Oculo-motor nerve (3rd cranial).
7. Trochlear nerve (4th cranial).
8. Abducent nerve (6th cranial).
9. Cavernous plexus of the sympathetic.
10. Great superficial petrosal nerve.
11. Small superficial petrosal nerve.

Dissection.—To expose these structures, the dura mater must be stripped from the inner part of the lateral portion of the middle cranial fossa. Enter the knife at the anterior clinoid process, and carry it backwards to the apex of the petrous bone. This incision must go no deeper than is necessary to divide the dura mater, and must be made immediately to the outer side of the openings in the membrane through which the oculo-motor, the trochlear, and trigeminal nerves pass. It is very important to preserve these apertures intact, so that the proximal ends of these nerves may be held in position during the dissection. The incision through the dura mater may now be carried along the upper border of the petrous bone in the line of the superior petrosal sinus, and also outwards along the posterior margin of the lesser wing of the sphenoid. The dura mater may now be raised, and the greatest care must be taken in doing so, because it is intimately connected with the nerves which lie subjacent to it. Thus, where it forms the outer wall of the cavernous sinus, it is closely applied to the oculo-motor and trochlear nerves, and firmly attached to the ophthalmic division of the trigeminal nerve, whilst over the petrous bone it is united to the surface of the Gasserian ganglion. The edge of the knife, therefore, must be kept close to the membrane, and a small portion of it may be left upon the nerves. This can afterwards be removed as the nerves are defined.

Cavernous Sinus (sinus cavernosus).—The cavernous sinus has been opened by the above dissection. It is a short, wide venous channel, which extends upon the side of the body of the sphenoid bone, from the lower and inner end of the sphenoidal fissure backwards to the apex of the petrous portion of the temporal bone. In front, blood is conducted into it by the ophthalmic veins and the sphenoparietal venous sinus; whilst behind, the blood is drained away by the superior and inferior petrosal venous sinuses. But it has still other connexions; thus, it receives some of the inferior cerebral veins, and internally it is brought into communication with the corresponding sinus of the opposite side by means of the anterior and posterior intercavernous sinuses (p. 129). Lastly, one or more emissary veins leave its under aspect, and, passing out of the cranium by the foramen ovale, or it may be through the foramen Vesalii when such exists in the sphenoid bone, connect it with the pterygoid venous plexus.

The cavernous sinus is formed in the same manner as the other venous sinuses. The two layers of the dura mater are separated from each other, and the interval is lined by a delicate membrane. A complicated network of interlacing trabeculæ occupies the lumen of the channel, and it is on this account that the term "cavernous" is applied to it. But, as we have already indicated, this sinus has a special importance, on account of its being traversed by the internal carotid artery, the cavernous plexus, and the oculo-motor, trochlear, and abducent nerves, with the ophthalmic division of the trigeminal nerve. The precise relation which these structures bear to its walls will be described later on; in the meantime, it is only necessary to state that two, viz., the internal carotid artery and the abducent nerve, lie more distinctly within the interval between the two layers of the dura mater than the others. They are shut out from the

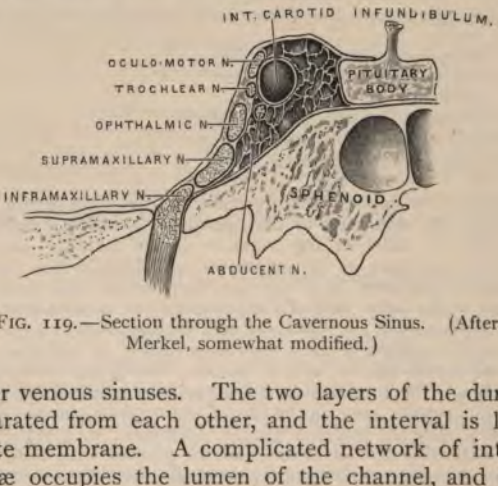


FIG. 119.—Section through the Cavernous Sinus. (After Merkel, somewhat modified.)

blood channel by the delicate lining membrane of the sinus. The oculo-motor and trochlear nerves, with the ophthalmic division of the trigeminal nerve, are closely applied to the outer wall of the sinus.

Trigeminal or Fifth Cranial Nerve (nervus trigeminus).—The two roots of this nerve have already been seen piercing the dura mater at the apex of the petrous portion of the temporal bone under the anterior extremity of the tentorium. Now that the dura mater has been raised from the lateral part of the middle cranial fossa, the further relations of these nerve-roots within the cranium may be studied. It will be noticed that the loosely connected and parallel funiculi of the large *sensory root* (portio major) at once begin to divide and join with each other so as to form a dense plexiform arrangement, whilst, at the same time, the nerve-root increases somewhat in breadth. The interlacement thus brought about occupies the smooth depression which marks the anterior aspect of the apex of the petrous portion of the temporal bone, and it sinks into the Gasserian ganglion.

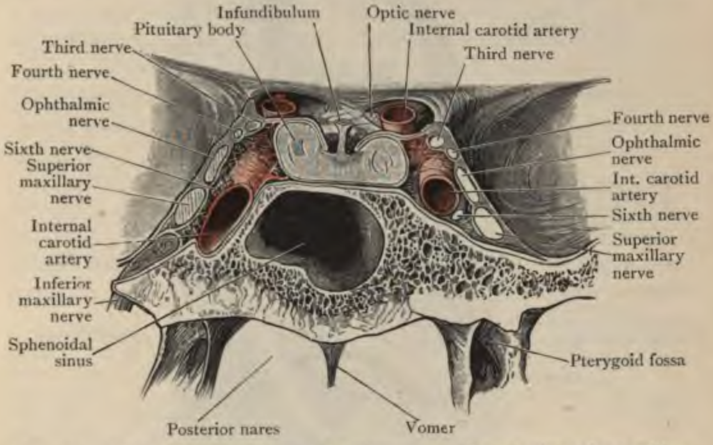

Infundibulum
Pituitary body
Optic nerve
Internal carotid artery
Third nerve
Third nerve
Fourth nerve
Ophthalmic nerve
Sixth nerve
Superior maxillary nerve
Internal carotid artery
Inferior maxillary nerve
Sphenoidal sinus
Fourth nerve
Ophthalmic nerve
Int. carotid artery
Sixth nerve
Superior maxillary nerve
Pterygoid fossa
Posterior nares
Vomer

FIG. 120.—Coronal section through the Cavernous Sinus to show the position of the Nerves in its wall. Note the branch given to the pituitary body by the internal carotid artery.

The *Gasserian ganglion* (ganglion semilunare) is somewhat crescentic in form, and lies upon the sutural junction between the apex of the petrous bone and the great wing of the sphenoid bone. Here it is enclosed within a recess or space formed by a separation of the two layers of the dura mater, and called the *cavum Meckelii*. The concavity of the ganglion is directed inwards, and it is upon this aspect that it receives the interlacing fibres of the sensory root of the trigeminal nerve; the convexity of the ganglion is directed outwards, and from it emerge the three main divisions of the trigeminal nerve. These are, from before backwards—(1) the first, or ophthalmic division; (2) the second, or superior maxillary division; and (3) the third, or inferior maxillary division. The outer surface of the Gasserian ganglion has already been observed to be closely attached to the deep surface of the supporting or inner layer of the dura mater. By its inner part it is connected with the sympathetic by some fine filaments which come from the carotid plexus.

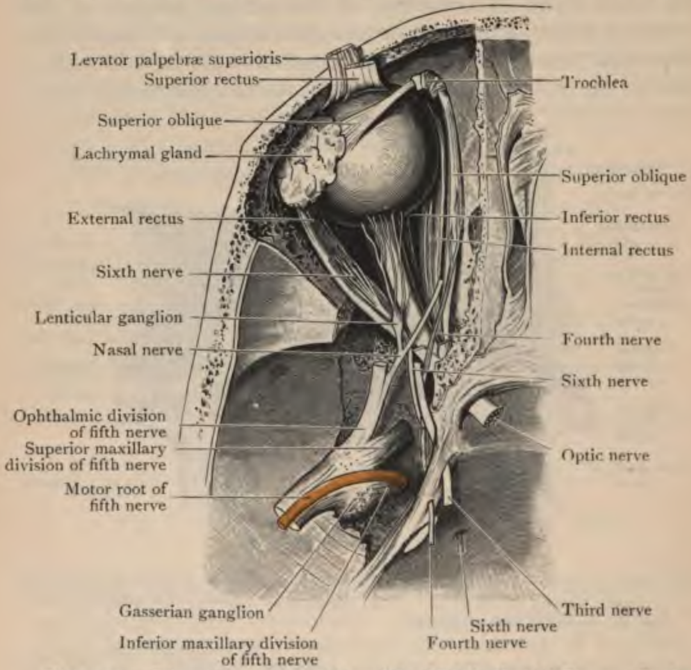

Levator palpebræ superioris
Superior rectus
Trochlea
Superior oblique
Lachrymal gland
Superior oblique
External rectus
Inferior rectus
Internal rectus
Sixth nerve
Lenticular ganglion
Fourth nerve
Nasal nerve
Sixth nerve
Ophthalmic division of fifth nerve
Superior maxillary division of fifth nerve
Optic nerve
Motor root of fifth nerve
Gasserian ganglion
Third nerve
Sixth nerve
Inferior maxillary division of fifth nerve
Fourth nerve

FIG. 121.—Dissection of the Orbit and the Middle Cranial Fossa. Both roots of the fifth nerve with Gasserian ganglion are turned outwards.

The *motor root* (portio minor) of the fifth nerve should now be followed. Before the nerve pierces the dura mater the motor root lies along the inner side of the large sensory root, but it soon changes its position and comes to lie upon the under surface of the sensory part. To display this relationship, draw the cut ends of the two roots through the aperture in the dura mater which leads into the cavum Meckelii, and, gently dislodging the Gasserian ganglion from its place, turn it forwards and outwards so as to expose its deep surface. The small firm motor root can readily be recognised lying in a groove upon the deep surface of the ganglion; and if it be raised from this, it will be seen to have no connexion with the ganglion, but to be continued onwards towards the foramen ovale. It ultimately joins the inferior maxillary division of the trigeminal nerve. This junction may take place within the cranium, in the foramen ovale, or immediately after it gains the exterior of the skull (p. 290).

The three principal divisions of the trigeminal nerve may next be examined. Begin with the *inferior maxillary division*, which is the largest. This proceeds directly downwards, and almost immediately leaves the cranial cavity through the foramen ovale.

In isolating this large nerve-trunk and defining the bony aperture through which it makes its exit, look carefully for the small meningeal artery which enters the cranium through the same foramen. If the injection has been forced into this vessel it can easily be detected. Through the foramen ovale the minute emissary veins which connect the cavernous sinus with the pterygoid venous plexus also pass.

The *superior maxillary division*, which is composed entirely of sensory fibres, is prolonged forwards in relation to the lower part of the cavernous sinus, and, after a short course within the cranium, makes its exit through the foramen rotundum. Near its origin it gives off a fine *recurrent branch* to the dura mater of the middle fossa of the cranium.

The *ophthalmic division* is the smallest of the three parts of the trigeminal nerve, and, like the supra-maxillary, it is entirely composed of sensory fibres. It proceeds forwards in the outer wall of the cavernous sinus, and ends close to the sphenoidal fissure by dividing into three terminal branches. As it traverses the sinus it is accompanied by the oculomotor and trochlear nerves, both of which occupy a higher level. Like the other two divisions of the trigeminal nerve, the ophthalmic nerve gives off a recurrent branch to the dura mater.

The terminal branches of the ophthalmic division of the trigeminal nerve are the nasal, the lachrymal, and the frontal. The *nasal*, as a rule, takes origin first; soon after, the *lachrymal* is given off, and then the stem of the nerve is continued onwards as the *frontal.* These three nerves enter the orbit through the sphenoidal fissure.

Third or Oculo-motor Fourth or Trochlear, and Sixth or Abducent Nerves.—The *oculo-motor* and *trochlear nerves*, as the dissector has previously noted, pierce the dura mater within the small triangular area, which is formed by the divergence of the attached and free margins of the tentorium. They now proceed forwards in the outer wall of the cavernous sinus. The third or oculo-motor nerve occupies the highest level, then comes the fourth or trochlear nerve, and immediately below this is the ophthalmic division of the fifth or trigeminal nerve. They therefore present a numerical order from above downwards. The *sixth* or *abducent nerve*, which pierces the dura mater at the lower and outer part of the dorsum sellæ, will be observed to wind round the outer side of the internal carotid artery, and then to proceed forwards more directly within the cavernous sinus than the others and at a lower level (Fig. 120).

The oculo-motor, trochlear, and abducent nerves give off no branches during their course in relation to the cavernous sinus. They all enter the orbit by passing through the sphenoidal fissure. Before doing so, the oculo-motor nerve divides into an upper and a lower division. During their passage through the sphenoidal fissure the various nerves undergo a change in their relative positions. This, however, will be studied in the dissection of the orbit when that fissure is opened up.

Internal Carotid Artery (arteria carotis interna).—The intracranial portion of the internal carotid artery may now be examined. It lies upon the lateral aspect of the body of the sphenoid, and for the greater part of its course it traverses the cavernous sinus. It enters the cranium by emerging from the carotid canal at the apex of the petrous bone, and it first ascends until it reaches the root of the posterior clinoid rocess; here it makes a bend and is prolonged forwards to e lower root of the anterior clinoid process, where it abruptly turns upwards and pierces the dura mater immediately behind the entrance of the optic nerve into the optic foramen and on the inner side of the anterior clinoid process. At this point it has been severed in the removal of the brain, but it will be afterwards seen to end at the commencement of the Sylvian fissure on the basal aspect of the brain, by dividing into the anterior and middle cerebral arteries. Throughout its whole course it is surrounded by sympathetic filaments, and soon after its entrance into the cranium the abducent nerve winds round its outer side.

The intracranial portion of the internal carotid artery gives off the following branches:—

1. Branches to the pituitary body,		These are minute twigs which arise in the cavernous sinus.
2. Branches to the Gasserian ganglion,		
3. Branches to the dura mater,		
4. Ophthalmic,		These will be studied at a later stage.
5. Posterior communicating,		
6. Anterior cerebral,	terminal branches.	
7. Middle cerebral,		

Cavernous Plexus (plexus cavernosus).—The sympathetic filaments which form this plexus can only be satisfactorily dissected in a subject which has not been injected; and even then, the dissection is an exceedingly difficult one. The *cavernous plexus* is placed in the cavernous sinus and is chiefly massed upon the lower and inner aspect of the internal carotid artery, at the point where it makes its bend upwards. It supplies filaments to the pituitary body, to the third and fourth nerves, and to the ophthalmic division of the fifth or trigeminal nerve, and likewise the sympathetic root to the lenticular or ophthalmic ganglion.

Great Superficial Petrosal Nerve.—This minute nerve, along with a small arterial twig from the middle meningeal artery, can readily be exposed in the groove on the anterior face of the petrous bone which leads outwards to the hiatus Fallopii. It is placed under cover of the Gasserian ganglion, which must therefore be turned forwards and outwards. Entering the hiatus Fallopii, the great superficial petrosal nerve is conducted to the aqueduct of Fallopius, where it joins the geniculate ganglion of the facial nerve. If traced in the opposite direction, it will be found at the posterior aspect of the body of the sphenoid bone to join the *large deep petrosal nerve* from the carotid plexus. The trunk formed by the union of these two filaments is the *Vidian nerve.*

The **Small Superficial Petrosal Nerve** appears upon the anterior face of the petrous bone through an aperture which is placed immediately external to the hiatus Fallopii. It leaves the cranial cavity by passing downwards between the great wing of the sphenoid, and the petrous part of the temporal bone, to reach the otic ganglion. This minute nerve, as has already been mentioned (p. 314), is formed by the union of the tympanic branch of the glosso-pharyngeal with a branch from the geniculate ganglion of the facial.

External Superficial Petrosal Nerve.—It is convenient at this stage to take note of a fourth petrosal nerve—*the external superficial petrosal.* It takes origin from the sympathetic plexus, which accompanies the middle meningeal artery, and, entering the petrous bone, is conducted to the geniculate ganglion of the facial nerve.

Middle and Small Meningeal Arteries.—The entrance of the *middle meningeal artery* through the foramen spinosum should now be examined. It gives minute twigs to the Gasserian ganglion, and one—the petrosal artery—which accompanies the great superficial petrosal nerve into the hiatus Fallopii. The further course of the middle meningeal artery has already been described (pp. 130 and 290). The small recurrent branch of the inferior maxillary division of the fifth nerve also enters the cranium through the foramen spinosum (p. 290).

The *small meningeal artery* enters the cranium through the foramen ovale, and is chiefly distributed to the Gasserian ganglion.

DISSECTION OF THE ORBIT.

Within the orbital cavity we find grouped around the eyeball and the optic nerve the following structures:—

Muscles, . .	Rectus superior. Rectus inferior. Rectus externus. Rectus internus. Obliquus superior. Obliquus inferior. Levator palpebræ superior.
Vessels, . .	Ophthalmic artery and its branches. Ophthalmic veins (superior and inferior) with their tributaries.

Nerves, . .
- Oculo-motor (3rd cranial).
- Trochlear (4th cranial).
- Abducent (6th cranial).
- Frontal, Lachrymal, Nasal, from ophthalmic division of the trigeminal or fifth cranial nerve.
- Orbital branch of the superior maxillary division of the trigeminal or fifth cranial nerve.

Lenticular ganglion.
Lachrymal gland.
The capsule of Tenon.

Dissection.—The roof of the orbit must be removed. The greater part of this dissection should be done with a sharp chisel. Begin by removing the thick cranial wall above the orbital opening, leaving only a thin portion corresponding to the superior orbital arch. Whilst this is being done, care should be taken to preserve the soft parts of the forehead and the upper eyelid. It is of great advantage to retain throughout the whole examination of the orbital cavity the bony ring which constitutes its opening on the face. The thin roof of the orbit may next be removed with the chisel. The lesser wing of the sphenoid, where it forms the upper boundary of the sphenoidal fissure, should be taken away by the bone pliers, but the dissector should carefully preserve intact the ring of bone around the optic foramen. The sphenoidal fissure is now fully opened up, and the various nerves, as they enter the orbit from the cavernous sinus, may be followed out. Lastly, the anterior clinoid process may be taken away with advantage.

Periosteum.—If the above dissection has been successfully carried out, the periosteum clothing the under surface of the orbital roof will be exposed uninjured. The periosteum of the orbit forms a funnel-shaped sheath, which encloses all the contents of the cavity, and is but loosely attached to its bony walls. Behind, it will be observed to be directly continuous through the sphenoidal fissure with the dura mater. Expanding with the cavity, it becomes continuous in front around the orbital opening with the periosteum, which clothes the exterior of the skull. Here also it presents important connexions with the palpebral ligaments (p. 273).

Reflection of the Periosteum and the subsequent Dissection.—The periosteum should be divided along the middle line of the orbit, and then transversely close to the orbital opening. It can now be thrown inwards and outwards. When this is done, the lachrymal gland will be exposed in the fore and outer part of the cavity resting upon the upper and outer aspect of the eyeball. Further, the large frontal nerve, lying upon the upper surface of the levator palpebræ superioris, will be seen stretching forwards in the middle line of the orbit; as it approaches the fore-part of the cavity, it is joined by the supra-orbital artery. The other superficial structures are usually more or less obscured by the soft pliable fat, which everywhere fills up the interstices between the different orbital contents. On carefully separating this, along the inner wall of the orbit, the superior oblique muscle will be more fully displayed, and lying upon and entering the hinder part of this muscle the small trochlear or fourth cranial nerve will be discovered. As a general rule the dissector fails to find this nerve, because he looks for it too far forwards. Lastly, the lachrymal nerve and artery will be found running along the outer wall of the orbit, above the level of the upper margin of the external rectus muscle.

These structures must be thoroughly cleaned and isolated by the removal of the fat from around them. In tracing the superior oblique muscle forwards, it will be found to end in a slender tendon, which passes through a ring-like pulley, attached to the frontal bone at the inner angle of the orbit. This pulley must be defined, and the tendon of the muscle followed onwards to its insertion into the eyeball. It will be observed that the levator palpebræ superioris lies upon the upper surface of the superior rectus, and if it be raised, a nerve twig will be noticed emerging from the substance of the rectus superior for the supply of the levator palpebræ muscle. This is a branch of the superior division of the third nerve.

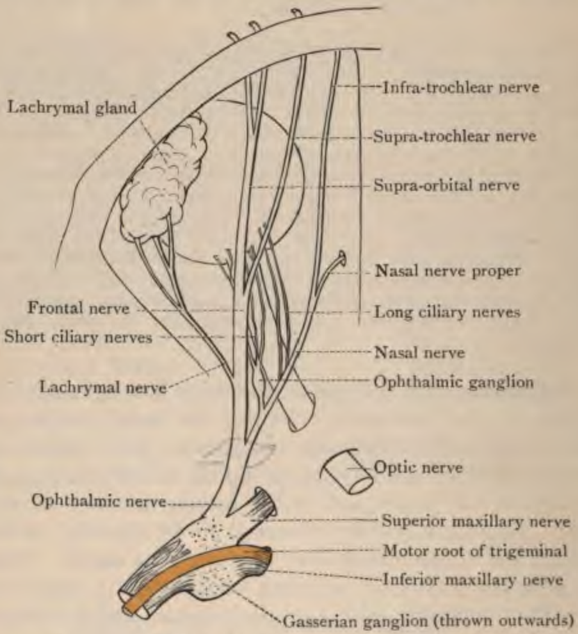

Lachrymal gland
Infra-trochlear nerve
Supra-trochlear nerve
Supra-orbital nerve
Nasal nerve proper
Frontal nerve
Long ciliary nerves
Short ciliary nerves
Nasal nerve
Lachrymal nerve
Ophthalmic ganglion
Optic nerve
Ophthalmic nerve
Superior maxillary nerve
Motor root of trigeminal
Inferior maxillary nerve
Gasserian ganglion (thrown outwards)

FIG. 122.—The Ophthalmic Nerve of the Left Side.

The dissection of the above parts will be facilitated by grasping the front of the eyeball with the forceps and drawing it forwards. It may be retained in this position by running a fine needle and thread through the ocular conjunctiva and stitching it to the nose. In doing this, however, take care that the needle does not penetrate the cornea, because this might render the subsequent inflation of the eyeball impossible.

Frontal Nerve (nervus frontalis).—The frontal nerve is the continuation of the stem of the ophthalmic division of the trigeminal or fifth nerve, after it has given off its lachrymal and nasal branches. It enters through the sphenoidal fissure above the muscles, and proceeds forwards upon the upper surface of the levator palpebræ superioris immediately subjacent to the periosteal lining of the orbital cavity. At a variable distance from the orbital opening, it ends by dividing into the supra-orbital and supra-trochlear nerves.

The *supra-trochlear nerve* is the inner and smaller of the two terminal branches of the frontal. It runs towards the pulley of the superior oblique muscle, above which it leaves the orbit, by turning round the orbital arch to reach the forehead. Its further course has already been described (pp. 107 and 265). In the orbit it gives off one small twig close to the pulley of the superior oblique muscle. This passes downwards to join the infra-trochlear branch of the nasal nerve.

The *supra-orbital nerve* is continued forward in the line of the parent stem, and, passing through the supra-orbital notch or foramen, it turns upwards on the forehead (pp. 109 and 265). In the dissection of the scalp this nerve has been seen to divide into an outer and inner division. Sometimes this division takes place within the orbit, and in that case the *outer* larger part occupies the supra-orbital notch.

Lachrymal Nerve (nervus lacrimalis).—This is the smallest of the terminal branches of the ophthalmic division of the fifth. It enters the orbit through the sphenoidal fissure above the level of the muscles, and proceeds forwards along the outer wall of the cavity, and above the upper margin of the external rectus muscle. At the fore-part of the orbit it continues its course under cover of the lachrymal gland until it reaches the outer part of the upper eyelid, in which it ends (p. 265). Within the orbital cavity it gives numerous twigs to the deep surface of the lachrymal gland, and sends downwards a filament which connects it with the orbital branch of the superior maxillary nerve.

Fourth Cranial Nerve (nervus trochlearis).—This small nerve is destined entirely for the supply of the superior oblique muscle. Entering the orbit through the sphenoidal fissure above the muscles, it is continued forwards and inward under the periosteum. It finally sinks into the upper orbital surface of the superior oblique muscle not far from its origin.

Lachrymal Gland.—The lachrymal gland is a small flattened body of an oval form, and distinctly lobular structure, which is placed obliquely in the fore and outer part of the orbital cavity. It consists of two parts or groups of lobules—an orbital and a palpebral—imperfectly separated from each other. The *orbital part* (glandula lacrimalis superior) constitutes the main mass of the gland. Its outer surface is convex, and is lodged in a hollow upon the inner aspect of the external angular process of the frontal bone. It is bound to the outer part of the orbital arch by short fibrous bands which proceed from the periosteum. The deep or inner surface is slightly concave, and rests upon the levator palpebræ superioris and external rectus, which intervene between it and the eyeball. The small *palpebral lobe* (glandula lacrimalis inferior) is placed in front of the orbital part, from which it is partially separated by the expanded tendon of the levator palpebræ superioris. It projects into the back part of the upper eyelid, and rests upon the conjunctiva which lines the under aspect of the lid. This portion of the gland has been already examined in the dissection of the eyelids (p. 276); but even in the undissected subject it can be seen through the conjunctiva if the upper eyelid be fully everted.

The lachrymal gland secretes the tears, and its ducts (three to five from the orbital part and three to nine from the palpebral part) open upon the under surface of the upper eyelid in the neighbourhood of the fornix (p. 277).

Levator Palpebræ Superioris.—This muscle rests upon the upper surface of the rectus superior. Behind, it is narrow and pointed, but it expands as it passes forwards above the eyeball to reach the upper eyelid. It arises from the under surface of the roof of the orbit immediately in front of the optic foramen, and in the fore-part of the orbital cavity it widens out into a broad membranous expansion, the connexions of which have already been described (p. 276). The outer and inner margins of this expansion are fixed to the rim of the orbital opening, in close proximity to the external and internal tarsal ligaments. By these attachments excessive action of the muscle upon the upper eyelid is in a measure checked.

Dissection.—The frontal nerve should be divided, and the ends thrown forwards and backwards. The levator palpebræ superioris may also be cut midway between its origin and insertion. On raising the posterior portion a minute nerve twig will be observed entering its deep or ocular surface. This comes from the superior division of the third or oculo-motor nerve.

The eyeball should now be inflated. This may be done from the front or from behind. If the latter method is selected, gently separate the fat under cover of the superior rectus muscle, and, pushing aside the ciliary nerves and vessels from the optic nerve, place a ligature around it close to the eyeball. A minute aperture should next be made in the sheath of the nerve behind the ligature, and, introducing a blow-pipe into this, thrust it forcibly forwards into the interior of the eyeball. The pipe should be provided with a stylette so as to keep the aperture free. When the globe of the eye is fully inflated, the ligature may be tightened as the blow-pipe is withdrawn. A very much better plan, however, is to inflate the eyeball from the front. For this purpose an oblique valvular aperture is made in an inward direction through the sclero-corneal junction, with the point of a sharp narrow-bladed knife. Through this the blow-pipe may be introduced, and on its withdrawal after the inflation of the eyeball the valvular character of the opening is sufficient to prevent the escape of the air.

At the back of the eyeball the dissector will notice a quantity of loose bursal-like tissue. This is the *Capsule of Tenon*. Seize the upper part of this with the forceps, and remove a small portion with a pair of scissors. An aperture is thus made into the capsule, and the handle of the knife can be introduced into the space between it and the eyeball. In favourable cases the extent of the capsule can be gauged, and perhaps even the prolongations or sheaths which it gives to the tendons of the ocular muscles made out. The description of the capsule of Tenon is given on p. 345.

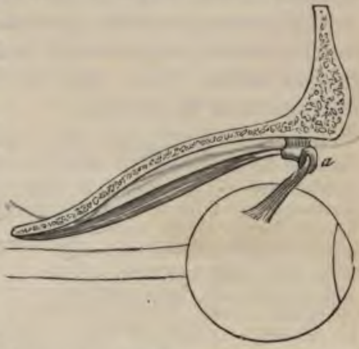


FIG. 123.—Diagram of the Superior Oblique Muscle. (From Hermann Meyer.)

a. Pulley and synovial sheath.

Rectus Superior.—The rectus superior, which lies under cover of the levator palpebræ superioris, is now fully exposed. It arises from the upper margin of the optic foramen, and, passing forwards above the optic nerve, ends upon the upper aspect of the eyeball in a thin, delicate tendon, which expands somewhat to be inserted into the sclerotic coat about three or four lines behind the sclero-corneal junction. It is supplied by a branch from the *superior division* of the *oculo-motor nerve*.

Superior Oblique Muscle (musculus obliquus superior).—This muscle arises from the roof of the orbit immediately in front of the upper and inner part of the optic foramen, and extends forwards along the inner wall of the cavity above the internal rectus. At the fore-part of the orbit it ends in a slender tendon, which enters the *pulley* and at once changes its direction. It now proceeds outwards and slightly backwards upon the upper surface of the eyeball, and under cover of the superior rectus. Beyond the outer edge of the latter muscle the tendon expands somewhat, and is inserted into the sclerotic coat midway between the entrance of the optic nerve and the cornea.

The *pulley* through which the tendon passes is a small fibro-cartilaginous ring, which is attached by fibrous tissue to the trochlear fossa—a depression in the frontal bone close to the internal angular process. The pulley is lined by a small synovial sheath which facilitates the movement of the tendon within it, and from its outer margin it gives a fibrous investment to the tendon.

Dissection.—The superior rectus muscle should now be divided midway between its origin and its insertion, and the cut ends thrown backwards and forwards. On raising the posterior part of the muscle the superior division of the third nerve is brought into view, and will be seen to sink into its deep or ocular surface, and at the same time send a twig to the levator palpebræ superioris. The removal of some fat will bring the optic nerve more fully into view. At the back part of the orbit three structures will be observed crossing the optic nerve—viz., (1) the nasal nerve; (2) the ophthalmic artery; and (3) the superior ophthalmic vein. These should be carefully cleaned and their branches followed out. From the nasal nerve, one or two delicate thread-like branches—the *long ciliary nerves*—will be found passing forwards along the optic nerve to reach the eyeball. The *short ciliary nerves*, much more numerous, accompany the long ciliary branches, and can readily be disengaged from the fat which surrounds the optic nerve. A strong member of this group should be selected and followed backwards; it will lead the dissector to the *lenticular* or *ophthalmic ganglion*. This is a minute body which is situated upon the outer side of the optic nerve far back in the orbit. With a little patience and care the roots which the nasal nerve and inferior division of the oculomotor or third nerve give to this ganglion can be isolated, and perhaps even the sympathetic root from the cavernous plexus may be found.

Optic Nerve (nervus opticus).—The optic nerve enters the orbit through the optic foramen. It carries with it a strong loose sheath of dura mater, and also a more delicate investment from the arachnoid. The ophthalmic artery which accompanies it lies in relation to its outer and lower aspect. Within the orbit the nerve inclines forwards and outwards, and at the same time somewhat downwards, and, gaining the back of the eyeball, it pierces the sclerotic coat a short distance to the inner side of its centre. As the dissector has already observed, its upper surface is crossed by the ophthalmic artery and vein and the nasal nerve, and it is closely accompanied by the delicate ciliary nerves and vessels. The optic nerve is slightly longer than the distance which it has to run from the optic foramen to the globe of the eye, so that the movements of the eyeball may not be interfered with. Within the eyeball the optic nerve spreads out in the retina.

Nasal Nerve (nervus naso-ciliaris).—The nasal nerve arises in the fore-part of the cavernous sinus from the ophthalmic division of the trigeminal. It passes through the sphenoidal fissure and enters the orbital cavity between the two heads of the external rectus muscle, and between the two divisions of the third nerve. It now inclines forwards and inwards, and, crossing the optic nerve obliquely, it runs between the internal rectus and superior oblique muscles. Here it reaches the inner wall of the orbit, and ends by dividing into two terminal branches—viz., the infra-trochlear and the nasal proper. In addition to these it gives off in the orbit the following branches:—

1. Long root to the lenticular ganglion.
2. Long ciliary nerves.

The *long ganglionic root* (radix longa ganglii ciliaris) is a very slender filament which springs from the nasal as it enters the orbit between the heads of the external rectus. It proceeds forwards on the outer side of the optic nerve, and enters the upper and back part of the lenticular ganglion.

The *long ciliary nerves* (nervi ciliares longi)—usually two in number—spring from the nasal as it crosses the optic nerve. They proceed forwards upon the inner side of the optic nerve to reach the globe of the eye, where they pierce the sclerotic. One of the long ciliary nerves very constantly unites with one of the short ciliary filaments.

The *infra-trochlear nerve* runs forwards along the inner wall of the orbit under cover of the superior oblique muscle. Passing under the trochlea of that muscle, it emerges from the orbit and appears upon the face, where it has already been dissected (p. 265). Near the pulley it receives a communicating twig from the supra-trochlear nerve.

The *nasal proper* is the larger of the two terminal branches of the nasal nerve. It leaves the orbit by the anterior internal orbital canal, and is conducted to the interior of the cranium in which it appears at the outer margin of the cribriform plat of the ethmoid. The canal in which it runs can readily t opened up by the bone pliers and the nerve exposed within it. Upon the cribriform plate it turns forwards under the dura mater, and almost immediately disappears through a slit-like aperture at the side of the crista galli, to reach the nasal cavity. Here it gives branches to the mucous membrane, and is continued downwards upon the posterior aspect of the nasal bone. Finally, it emerges upon the face by passing between the lower margin of the nasal bone and the upper lateral cartilage of the nose. Its terminal filaments have already been described (p. 265).

The *nasal nerve proper*, therefore, takes a most circuitous route, being found—(1) in the orbit; (2) in the cranium; (3) in the nasal fossa; and (4) in the face.

Lenticular Ganglion (ganglion ciliare)—(Fig. 122).—The lenticular ganglion is a minute quadrangular body, not much larger than the head of a large pin; but its size varies considerably in different subjects. It is placed in the back part of the orbit between the optic nerve and the external rectus muscle, and very commonly on the outer side of the ophthalmic artery. By its posterior border it receives its three roots; whilst from its anterior border the short ciliary nerves are given off.

The *sensory root* comes from the nasal, and is called the *long root*. It enters the upper and hinder angle of the ganglion. The *short* or *motor root* is a short, stout trunk; it comes from the branch of the oculo-motor nerve, which goes to the inferior oblique muscle, and it enters the lower and hinder angle of the ganglion. The *sympathetic root* comes from the cavernous plexus, and joins the posterior border of the ganglion, close to the entrance of the long root from the nasal nerve. In some cases it joins the long root before it reaches the ganglion.

The *short ciliary nerves* (nervi ciliares breves) are from four to six in number, and they come off in two groups, of which one emerges from the upper and fore angle of the ganglion, whilst the other springs from its lower and fore angle. The lower group is generally more numerous than the upper. As these fine nerves proceed along the optic nerve they divide, and thus increase in number; at the back of the eyeball from twelve to eighteen may be counted. Finally they pierce the sclerotic by a series of apertures which are placed around the entrance of the optic nerve.

Ophthalmic Artery (arteria ophthalmica).—The ophthalmic artery is a branch of the internal carotid, and it accompanies the optic nerve into the orbit through the optic foramen. At first it lies below the optic nerve, but it soon winds round the outer side of the nerve, and crossing it superficially proceeds forwards along the inner wall of the orbit, under cover of the superior oblique muscle. At the inner angle of the orbit it ends by dividing into two terminal branches—viz., the frontal and the nasal (Fig. 125).

The *branches* of the ophthalmic artery are very numerous, and they can seldom be satisfactorily displayed, unless a special injection has been made, or a cold injection used. They are:—

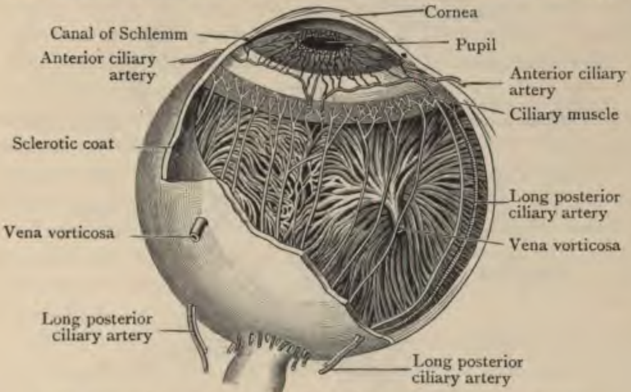

Cornea
Canal of Schlemm
Pupil
Anterior ciliary artery
Anterior ciliary artery
Ciliary muscle
Sclerotic coat
Long posterior ciliary artery
Vena vorticosa
Vena vorticosa
Long posterior ciliary artery
Long posterior ciliary artery

FIG. 124.—Dissection of the Eyeball showing the Distribution of the Ciliary Nerves and Vessels.

1. The lachrymal.
2. Muscular.
3. Arteria retinæ centralis.
4. Ciliary.
5. Supra-orbital.
6. Ethmoidal.
7. Palpebral.
8. Nasal.
9. Frontal.

The *lachrymal artery* (arteria lacrimalis) accompanies the lachrymal nerve, and supplies the gland of that name and the conjunctiva. Two branches, named *external palpebral* (arteriæ palpebrales laterales), form an arch (arcus tarseus) in each eyelid, near the free margin, with the internal palpebral arteries.

The *muscular twigs* (rami musculares) come off at variable points, not only from the main artery, but also from certain of its branches. They supply the muscles contained in the orbital cavity.

The *arteria retinæ centralis* is a minute but important artery. It pierces the inner and under aspect of the optic nerve about half an inch behind the eyeball, and is conducted in its substance to the interior of the globe of the eye.

The *ciliary arteries* are very numerous. Two groups are recognised—viz., a posterior and an anterior. The *posterior ciliary arteries* run with the ciliary nerves. They arise by two trunks which spring from the ophthalmic whilst it lies below the optic nerve. These divide into several slender branches, which pierce the sclerotic around the entrance of the optic nerve. Two members of this group of vessels enter the eyeball on either side of the optic nerve, somewhat apart from the others. They are termed the *long ciliary arteries* (arteriæ ciliares posteriores longæ) (Fig. 124). The *anterior ciliary arteries* (arteriæ ciliares anteriores) come off in the fore-part of the orbit from the lachrymal and muscular branches. They vary in number from six to eight, and

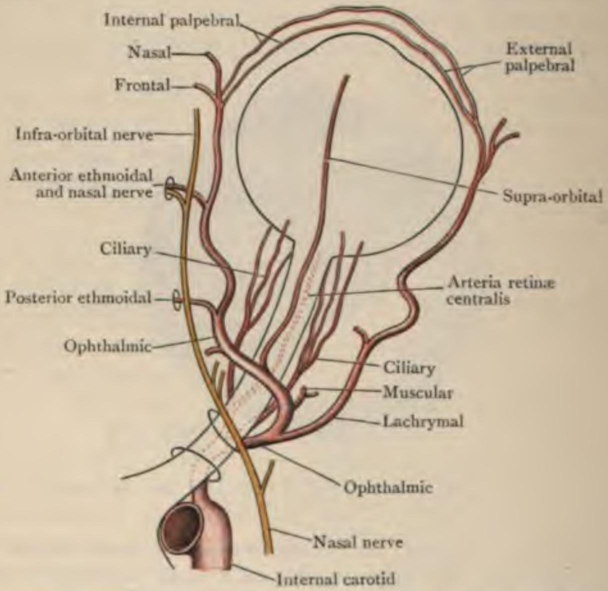

Internal palpebral
Nasal
Frontal
Infra-orbital nerve
Anterior ethmoidal and nasal nerve
Ciliary
Posterior ethmoidal
Ophthalmic
External palpebral
Supra-orbital
Arteria retinæ centralis
Ciliary
Muscular
Lachrymal
Ophthalmic
Nasal nerve
Internal carotid

FIG. 125.—Diagram of the Ophthalmic Artery and its Branches. (After Quain and Meyer, modified.)

run to the anterior part of the eyeball, where they form an arterial circle under the conjunctiva. Finally, they pierce the sclerotic immediately behind the cornea.

The *supra-orbital artery* (arteria supraorbitalis) accompanies the supra-orbital nerve, and thus gains the forehead, where it has been dissected at a previous stage (p. 111).

The *ethmoidal arteries* are two in number—anterior and posterior—and they run to the anterior and posterior internal orbital foramina on the inner wall of the orbit. The *posterior ethmoidal artery* (arteria ethmoidalis posterior) supplies the mucous lining of the posterior ethmoidal cells, and sends twigs to the upper part of the nose. The *anterior ethmoidal artery* (arteria ethmoidalis anterior) is a larger branch. It runs in company with the nasal nerve proper, and gives off minute twigs at each stage of its course. Thus in the anterior internal orbital canal it gives branches to the mucous lining of the anterior ethmoidal cells and the frontal sinus; during its short sojourn in the cranial cavity it supplies the small *anterior meningeal artery* (arteria meningea anterior) (p. 130); in the nasal cavity it gives twigs to the mucous membrane; whilst its terminal branch appears on the face to supply parts on the side of the nose.

The *internal palpebral branches* (arteria palpebrales mediales) come off near the orbital opening, and are two in number—one for the upper and the other for the lower eyelid (p. 276).

The *nasal branch* (arteria dorsalis nasi) is distributed at the root of the nose, and anastomoses with the angular branch of the facial artery.

The *frontal artery* (arteria frontalis) accompanies the supra-trochlear nerve to the forehead, where it has already been dissected (p. 111).

Ophthalmic Veins.—As a general rule these are two in number—superior and inferior. The *superior ophthalmic vein* is the larger of the two, and it accompanies the artery across the optic nerve. It takes origin at the root of the nose, where it communicates by a wide radicle with the angular vein. The *inferior ophthalmic vein* lies deeper, below the level of the optic nerve, and it is brought into communication with the pterygoid venous plexus by an offset which passes through the spheno-maxillary fissure. The two ophthalmic veins receive numerous tributaries during their course through the orbit, and finally they pass between the two heads of the external rectus muscle, and through the sphenoidal fissure to open into the cavernous sinus, either separately or by a common trunk.

Recti Muscles.—The four straight muscles of the eyeball converge to the apex of the orbit, and together form the sides of a four-sided or pyramidal space, in which are enclosed the optic nerve and the greater part of the globe of the eye. The *rectus superior*, which has been reflected, has already been studied. The *rectus internus* springs from the inner side of the optic foramen, and the *rectus inferior* takes origin from a fibrous band which bounds the inner extremity of the sphenoidal fissure. The *rectus externus* is distinguished from the others by arising from a fibrous arch, the extremities of which are termed its two heads of origin. The *lower head* arises in common with the rectus inferior from the body of the sphenoid, where this bounds the inner end of the sphenoidal fissure; the *upper head* is attached above the sphenoidal fissure upon the outer side of the optic foramen, where its origin becomes continuous with that of the superior rectus. Through the archway which intervenes between the two heads of the external rectus pass the two

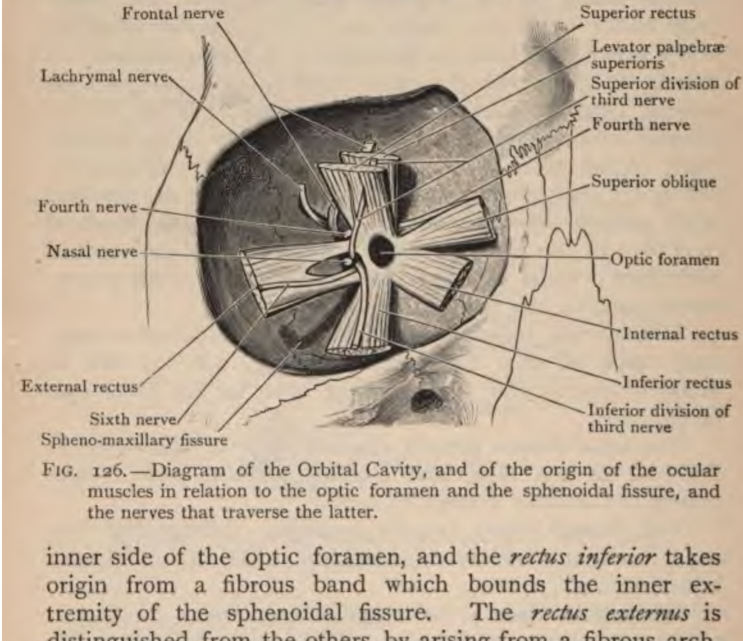

Frontal nerve
Superior rectus
Lachrymal nerve
Levator palpebræ superioris
Superior division of third nerve
Fourth nerve
Superior oblique
Fourth nerve
Nasal nerve
Optic foramen
Internal rectus
External rectus
Inferior rectus
Sixth nerve
Inferior division of third nerve
Spheno-maxillary fissure

FIG. 126.—Diagram of the Orbital Cavity, and of the origin of the ocular muscles in relation to the optic foramen and the sphenoidal fissure, and the nerves that traverse the latter.

divisions of the oculo-motor nerve, the nasal nerve, the abducent nerve, and the ophthalmic veins (Fig. 126).

A better view of these attachments may be obtained by dividing the optic nerve close to the optic foramen and turning forwards the eyeball.

The manner in which the recti muscles are inserted into the eyeball should next be studied. Each ends in a delicate membranous tendon, which is inserted into the sclerotic coat, about a quarter of an inch behind the sclero-corneal junction.

Third Nerve (nervus oculomotorius).—The two divisions of this nerve enter the orbit through the sphenoidal fissure, between the two heads of the external rectus. The *superior division* has been traced to the rectus superior and the levator palpebræ superioris. The *inferior division* is much the larger of the two, and almost immediately divides into three branches for the supply of the rectus internus, the rectus inferior, and the obliquus inferior. The nerves to the two recti enter the ocular surfaces of these muscles; the nerve to the inferior oblique is a long branch, which is prolonged forwards in the interval between the rectus inferior and rectus externus, and enters the hinder border of the inferior oblique muscle. Soon after its origin this branch gives the *short motor root* to the lenticular ganglion, and likewise supplies two or three additional filaments to the inferior rectus muscle.

Sixth Nerve (nervus abducens).—The sixth nerve will be found closely applied to the ocular surface of the external rectus, and it enters the orbit by passing through the narrow interval between the heads of this muscle. It is destined entirely for the supply of the rectus externus.

Arrangement of the Nerves in the Sphenoidal Fissure.—Now that the orbit is dissected, and the various nerves which were met in the dissection of the cavernous sinus traced into the cavity, the dissector will observe that the arrangement of these nerves in the sphenoidal fissure is somewhat different from that in the sinus.

The lachrymal, frontal, and trochlear or fourth nerves enter the orbit above the muscles on very much the same plane (Fig. 126). The other nerves enter between the heads of the external rectus. Of these the superior division of the oculo-motor nerve is the highest, next comes the nasal nerve, then the inferior division of the oculo-motor nerve, whilst the abducent nerve occupies the lowest level.

Dissection.—The inferior oblique muscle is placed very differently from the other muscles of the orbit. It is situated below the eyeball, and turns round its inferior and outer surface. It must be dissected from the front. It is necessary, therefore, to restore the eyeball to its natural place. Next, evert the lower eyelid and remove the conjunctiva from its deep surface as it is reflected on to the globe of the eye. A little dissection in the floor of the fore-part of the orbit and the removal of some fat will reveal the inferior oblique muscle.

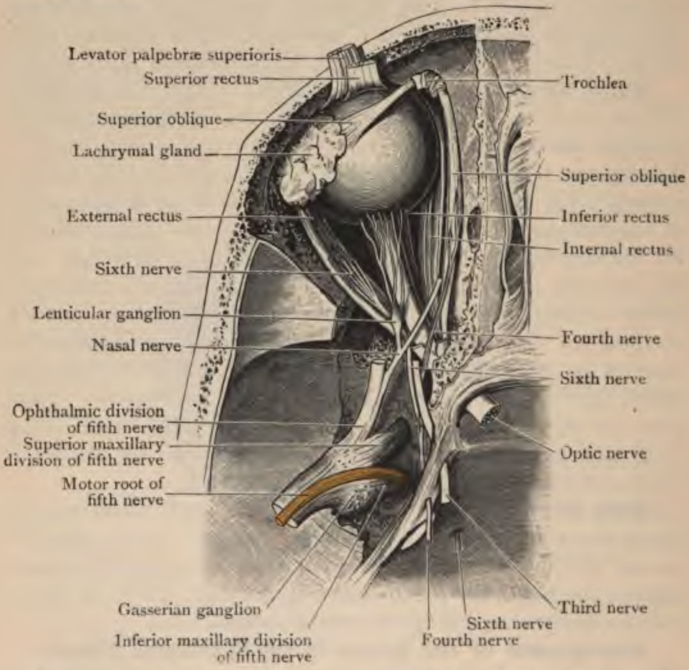

Levator palpebræ superioris
Superior rectus
Trochlea
Superior oblique
Lachrymal gland
Superior oblique
External rectus
Inferior rectus
Internal rectus
Sixth nerve
Lenticular ganglion
Fourth nerve
Nasal nerve
Sixth nerve
Ophthalmic division of fifth nerve
Superior maxillary division of fifth nerve
Optic nerve
Motor root of fifth nerve
Gasserian ganglion
Third nerve
Sixth nerve
Inferior maxillary division of fifth nerve
Fourth nerve

FIG. 127.—Dissection of the Orbit and the Middle Cranial Fossa. Both roots of the fifth nerve with Gasserian ganglion are turned outwards.

Inferior Oblique (musculus obliquus inferior).—This muscle arises from a small depression on the orbital plate of the superior maxillary bone immediately to the outer side of the opening of the nasal duct. It passes outwards below the inferior rectus muscle, and, inclining slightly backwards, ends in a thin membranous tendon, which gains insertion into the outer aspect of the sclerotic coat of the eyeball under cover of the rectus externus. This insertion is not far from that of the superior oblique, but is placed farther back. A branch of the *inferior division* of the *third nerve* has been traced to the posterior margin of the inferior oblique muscle.

Capsule of Tenon (fascia bulbi).—This is a firm, loose membrane in relation to the globe of the eye. Its connexions are somewhat complicated, and they cannot in every detail be satisfactorily displayed in an ordinary dissection. It may be studied from a threefold point of view—(1) in its connexion with the eyeball; (2) in its connexions with the muscles inserted into the globe of the eye; and (3) in its connexions with the walls of the orbit.

The relation which the capsule of Tenon exhibits to the eyeball is very simple. The membrane is spread over the posterior five-sixths of the globe—the cornea alone being free from it. In front, it lies under the ocular conjunctiva, with which it is intimately connected, and it ends by blending with the conjunctiva close to the margin of the cornea. Behind, it fuses with the sheath of the optic nerve, where the latter pierces the sclerotic. The anterior surface of the membrane (*i.e.*, the surface towards the globe of the eye) is smooth, and is connected to the eyeball by some soft yielding and humid areolar tissue, the interval between them in fact constituting an extensive lymph space. Its posterior surface is in contact with the orbital fat, to which it is loosely adherent, while farther forwards, as we have noted, this surface is firmly attached to the ocular conjunctiva. It is apparent, therefore, that by this membrane a socket is formed for the eyeball, in which it can glide with the greatest freedom.

The tendons of the various ocular muscles are inserted into the eyeball within this capsule, and they gain its interior by piercing the membrane opposite the equator of the globe (Fig. 128). The lips of the openings through which the four recti muscles pass are prolonged backwards upon the muscles, in the form of sheaths, very much in the same manner that the infundibuliform fascia is prolonged upon the spermatic cord from the internal abdominal ring. These sheaths gradually become more and more attenuated until at last they blend with the perimysium of the muscular bellies. In the case of the superior oblique muscle the corresponding prolongation is only related to its reflected portion; it reaches the pulley, and there it ends by becoming attached to its margin. The sheath of the inferior oblique may be traced upon the muscle as far as the floor of the orbit. The inner or ocular edge of each of the four apertures through which the recti muscles pass is strengthened by a slip of fibrous tissue (Lockwood). The importance of these slips will be understood when we remember that the capsule of Tenon is at various points firmly bound to the bony wall of the orbit. They therefore act as pulleys, and protect the globe of the eye from pressure during contraction of the muscles. The aperture for the superior oblique is not furnished with such a slip, and it is doubtful if the opening for the inferior oblique muscle possesses one.

Dissection.—An admirable view of the relations which the capsule of Tenon presents to the eyeball and the tendons of the ocular muscles can be obtained by the following dissection :—Divide the outer canthus of the eyelids as far out as the margin of the orbital opening. Pull the eyelids widely apart, so as to expose as much as possible of the anterior face of the eyeball. Next divide the conjunctiva by a circular incision just outside the cornea. At this point the capsule of Tenon is so intimately connected with the conjunctiva that it is divided at the same time. Now raise carefully both conjunctiva and Tenon's capsule from the surface of the eyeball, and spread them out round the orbital opening, as is depicted in Fig. 128. The openings in the capsule of Tenon for the tendons of the ocular muscles and the thickened margins of these apertures are well seen. Note also the sheaths which are given to the muscles.

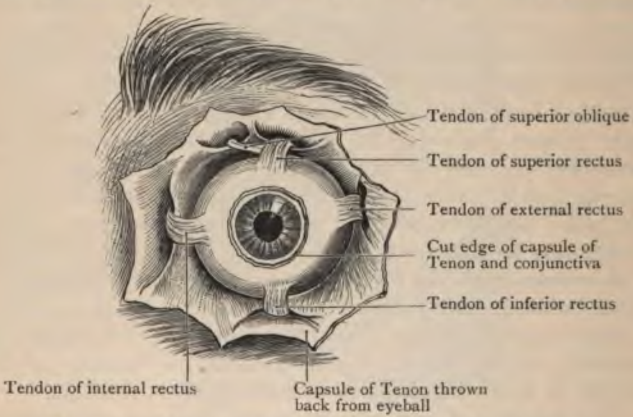

Tendon of superior oblique
Tendon of superior rectus
Tendon of external rectus
Cut edge of capsule of Tenon and conjunctiva
Tendon of inferior rectus
Tendon of internal rectus
Capsule of Tenon thrown back from eyeball

FIG. 128.—Dissection of the Capsule of Tenon from the front.

Check and Suspensory Ligaments.—The connexions of the capsule of Tenon to the walls of the orbital cavity are somewhat complicated. The *suspensory ligament* (Lockwood) plays an important part in this respect. It stretches across the fore-part of the orbit, after the fashion of a hammock, and gives support to the eyeball. Its two extremities are narrow, and are attached respectively to the malar and lachrymal bones. Below the eyeball it widens out and forms a part of the capsule of Tenon. The *external* and *internal check ligaments* also constitute bonds of union between the capsule of Tenon and the orbital wall. They are strong bands which pass from the sheaths around the external and internal recti muscles to obtain attachment to the malar and lachrymal bones respectively; here they are brought into association with the extremities of the suspensory ligament. The function of the check ligaments is easily understood. They limit the contraction of the external and internal recti muscles, and thus prevent excessive rotation of the eyeball in an outward or inward direction. There is a similar but less direct provision by means of which the action of the superior and inferior recti muscles is limited. The action of the former muscle is checked through its intimate connexion with the levator palpebræ superioris in the fore-part of the orbit; the action of the inferior rectus is checked through its connexion with the suspensory ligament.

Dissection.—In order that the temporo-malar, or orbital branch of the superior maxillary division of the trigeminal nerve, may be displayed in its course through the orbit, the orbital contents must be removed. It will then be found in the midst of a little soft fat in the angle between the floor and outer wall of the orbit.

Temporo-malar Nerve (nervus zygomaticus).—This small nerve arises in the spheno-maxillary fossa, from the superior maxillary division of the trigeminal nerve, and it enters the orbit by passing through the spheno-maxillary fissure. It almost immediately divides into two terminal branches—viz., the temporal and the malar.

The *temporal branch* (ramus zygomaticotemporalis) runs forwards and upwards upon the outer wall of the orbit, under cover of the periosteum, and, after receiving a communicating twig from the lachrymal nerve, it enters the temporal canal of the malar bone. This conducts it to the fore-part of the temporal region, where it has already been examined (pp. 109 and 265).

The *malar branch* (ramus zygomaticofacialis) continues forward in the angle between the floor and outer wall of the orbit, and is finally conducted to the face by a minute canal which perforates the malar bone. Here it has been displayed in the dissection of the face (p. 265).

PREVERTEBRAL REGION.

The following are the structures to be displayed in this dissection :—

Prevertebral muscles.
Intertransverse muscles.
Cervical nerves.
Vertebral artery.
Vertebral vein.
Vertebral and cranio-vertebral articulations.

Dissection.—In order that we may obtain a proper view of the pharynx and the prevertebral muscles, it is necessary to make a somewhat complicated dissection. The fore-part of the skull bearing the pharynx must be separated from the back part of the skull and the cervical portion of the vertebral column. Place the preparation upside down, so that the cut margin of the skull rests upon the table, and, having divided the common carotid artery, the internal jugular vein, the vagus nerve, and the sympathetic cord on each side at the level of the neck of the first rib, draw the trachea and œsophagus, together with the great blood vessels and nerves, forwards from the anterior surface of the vertebral column. This separation must be effected right up to the base of the skull. At this point great caution must be observed, otherwise the pharyngeal wall or the insertions of the prevertebral muscles will be damaged. The base of the skull having been reached, the point of the knife should be carried across the basilar process of the occipital bone between the pharynx and the vertebral muscles, so as to divide the thick investing periosteum.

The basilar process must now be divided by means of a chisel. Still retaining the part upside down, place the skull so that its floor rests upon the end of a wooden block. Then apply the edge of the chisel to the under surface of the basilar process, adjust it accurately in the interval between the pharyngeal wall and the prevertebral muscles, and with a wooden mallet drive it through the base of the skull, inclining it, at the same time, slightly backwards.

The next step in the dissection consists in making two saw-cuts through the cranial wall. The head having been placed upon its side, the saw must be applied to the outer aspect of the skull half an inch behind the mastoid process, and carried obliquely forwards and inwards to reach a point immediately behind the jugular foramen. The same saw-cut must be repeated upon the opposite side of the head.

To complete the dissection the dissector must again have recourse to the chisel. Placing the preparation so that the floor of the cranium looks upwards, divide the base of the skull, on each side, in the interval between the petrous portion of the temporal bone and the basilar portion of the occipital bone. In front, this cut should reach the outer extremity of the incision already made through the basilar process ; whilst behind, it should be carried backwards upon the inner side of the jugular foramen to reach the inner end of the saw-cut. When this has been done upon both sides of the basilar process, the fore-part of the skull carrying the pharynx and the great blood-vessels and nerves can be separated from the back part of the skull and cervical portion of the vertebral column. The only large nerve which will be divided is the hypoglossal, but, as it is cut close to the basis cranii, and below this it is firmly connected with the trunk ganglion of the vagus, it retains its position.

The pharynx and anterior portion of the skull should now be covered with a piece of cloth soaked in the spirit and carbolic solution, and the whole enveloped in an oil-cloth wrapper. It can then be laid aside until the dissection of the prevertebral region and the ligaments of the cervical vertebræ and the occiput have been studied.

Returning to the posterior part of the skull and the cervical portion of the spine, the dissector should proceed to define the attachments of the muscles which lie in front of the transverse processes and the bodies of the vertebræ. These are three in number on each side, viz. :—

1. The longus colli.
2. The rectus capitis anticus major.
3. The rectus capitis anticus minor.

Longus Colli.—This is the most powerful of the prevertebral muscles, and it lies nearest to the mesial plane. Its connexions are somewhat intricate, but when it has been thoroughly cleaned it will be seen to consist of three portions —viz., an upper and lower oblique part, and an intermediate vertical part.

The *lower oblique* division of the longus colli arises from the lateral aspect of the bodies of the upper two or three dorsal vertebræ. It extends upwards and slightly outwards, and ends in two tendinous slips which are inserted into the anterior tubercles of the transverse processes of the fifth and sixth cervical vertebræ. In the interval between this portion of the longus colli and the scalenus anticus, the vertebral artery will be observed. The *upper oblique* part of the longus colli arises by three tendinous slips from the anterior tubercles of the transverse processes of the third, fourth, and fifth cervical vertebræ, and tapers somewhat as it proceeds upwards and inwards, to obtain a pointed and tendinous insertion into the anterior tubercle of the atlas. The *vertical part* of the muscle is much the largest of the three divisions, and it lies along the inner side of the oblique portions, with both of which it is more or less intimately connected. Thus, below, it arises in common with the inferior oblique part by two or three slips from the sides of the bodies of the upper two or three dorsal vertebræ; above this it derives additional slips of origin from the bodies of the lower two cervical vertebræ; lastly, its outer border is reinforced by slips from the transverse processes of the lower three or four cervical vertebræ. It stretches vertically upwards and is inserted upon the inner side of the upper oblique part of the muscle, by three tendinous processes, which obtain attachment to the bodies of the second, third, and fourth cervical vertebræ.

Rectus Capitis Anticus Major.—The rectus capitis anticus major is an elongated muscle which arises by four tendinous slips from the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ, and is inserted in front of the foramen magnum, upon the under aspect of the basilar process of the occipital bone. To reach this insertion the muscle inclines slightly inwards as

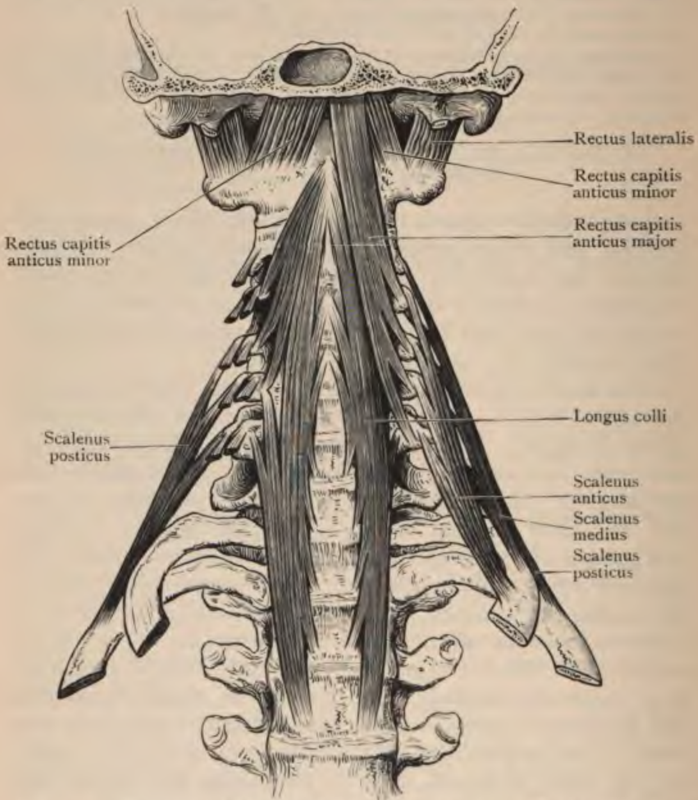

Rectus lateralis
Rectus capitis anticus minor
Rectus capitis anticus minor
Rectus capitis anticus major
Longus colli
Scalenus posticus
Scalenus anticus
Scalenus medius
Scalenus posticus

FIG. 129.—Prevertebral Muscles of the Neck. On the right side the rectus capitis anticus major has been removed. (Paterson.)

it ascends upon the front of the vertebral column. It is supplied by twigs from the *first loop* of the *cervical plexus*.

Rectus Capitis Anticus Minor.—This is a small muscle. It is in great part concealed by the upper part of the preceding muscle, which should be detached from its insertion, and turned downwards so as to bring it fully into view. It arises from the anterior aspect of the root of the transverse process of the atlas, and proceeding upwards and inwards is inserted into the under surface of the basilar process of the occipital bone behind the rectus capitis anticus major. It is supplied by a filament from the *first loop* of the *cervical plexus*.

Before proceeding farther, the dissector should again examine the attachments of the scalene muscles (*v.* p. 216).

Intertransverse Muscles (musculi intertransversarii).—To obtain a proper display of the intertransverse muscles it will be necessary to remove the prevertebral and scalene muscles. The intertransverse muscles consist of seven pairs of small fleshy slips, on each side, which connect the bifid extremities of the cervical transverse processes. The anterior slip of each muscle is attached to the anterior tubercles of two adjacent transverse processes; whilst the posterior slip extends between the posterior tubercles. The highest pair of muscular slips lies between the atlas and the axis; the lowest pair connects the transverse process of the seventh cervical vertebra with the transverse process of the first dorsal vertebra.

Cervical Nerves.—The cervical spinal nerves will be observed to have a very definite relation to the intertransverse muscles. The anterior primary branches of the lower six cervical nerves make their appearance by passing outwards *between* the two slips of the corresponding muscles. The posterior primary divisions of the same nerves turn backwards *behind* the posterior muscular slips.

The upper two cervical nerves emerge from the spinal canal differently from the others. They pass backwards over the neural arches of the atlas and axis respectively. The *first* or *suboccipital nerve* has been sufficiently examined at a previous stage of the dissection (p. 322); but the dissector is now in a position to observe that the *anterior primary division* of the *second cervical nerve* turns forwards under cover of the posterior slip of the first intertransverse muscle, and winds round the outer side of the vertebral artery, to appear in front of the anterior slip of the same muscle.

Dissection.—The vertebral artery as it traverses the succession of foramina in the transverse processes of the cervical vertebræ should now be exposed. Remove the intertransverse muscles as well as the muscles still attached to the transverse process of the atlas—viz., the rectus lateralis, the inferior oblique, and the superior oblique. The anterior tubercles and the costal portions of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ should then be snipped off by the bone pliers.

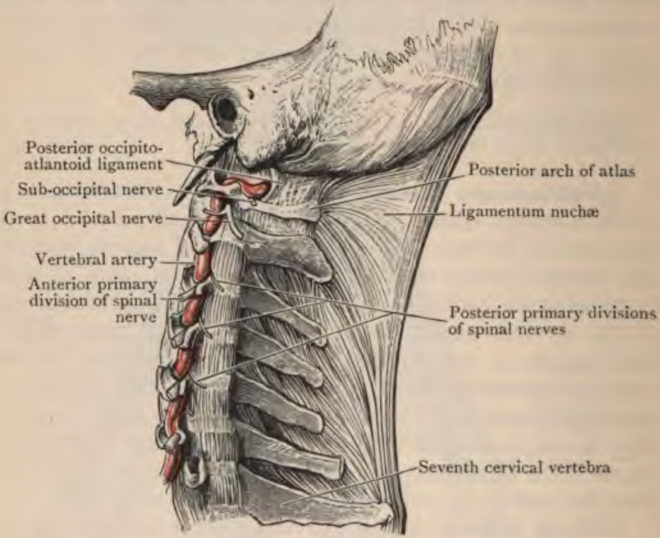

Posterior occipito-atlantoid ligament
Sub-occipital nerve
Great occipital nerve
Vertebral artery
Anterior primary division of spinal nerve
Posterior arch of atlas
Ligamentum nuchæ
Posterior primary divisions of spinal nerves
Seventh cervical vertebra

FIG. 130.—Dissection of the Ligamentum Nuchæ and of the Vertebral Artery in the Neck.

Vertebral Artery (arteria vertebralis).—This vessel has previously been traced to the point where it disappears through the foramen in the transverse process of the sixth cervical vertebra; it is now seen to proceed vertically upwards through the succession of foramina transversaria until it reaches the foramen in the transverse process of the axis. In this it is directed outwards in order that it may gain the more outwardly placed foramen of the atlas. Upon the upper surface of the atlas it again changes its direction and proceeds backwards, behind the lateral mass, in a groove on the upper surface of the posterior arch of that bone. Finally, it turns forwards under the posterior occipito-atlantal ligament, pierces the dura mater, and enters the cranium through the foramen magnum.

The vertebral artery is accompanied by a sympathetic plexus of nerves derived from the inferior cervical ganglion, whilst the vertebral vein breaks up in a plexiform manner around it. The anterior divisions of the lower six cervical nerves pass outwards behind it; the corresponding division of the first cervical nerve passes forwards internal to it, whilst that of the second nerve turns forward upon its outer aspect; lastly, the posterior primary division of the first cervical nerve enters the suboccipital triangle of the neck by passing backwards between the artery and the neural arch of the atlas.

The *branches* which are given off by the vertebral artery in the neck are of small size. They are (*a*) muscular; (*b*) lateral spinal.

The *muscular twigs* go to the muscles in the neighbourhood. The *lateral spinal branches* enter the spinal canal upon the cervical nerves, and have been described on p. 158.

Vertebral Vein.—The vertebral vein does not take origin within the cranium. It merely accompanies the vertebral artery in the cervical part of its course, and forms a close venous plexus around it as it proceeds through the succession of bony foramina in the transverse processes of the cervical vertebræ. Its radicles arise in the suboccipital region, where they anastomose with the tributaries of the occipital and deep cervical veins. Before it enters the transverse process of the atlas it receives a large offset from the intra-spinal venous plexus. Inferiorly, the vertebral vein opens into the innominate vein (p. 221).

Dissection.—The muscles must now be completely removed, in order that the vertebral and cranio-vertebral joints, and the ligaments in connexion with the cervical portion of the spine, may be examined.

THE JOINTS OF THE NECK.

The axis, atlas, and occipital bone present a series of articulations in which the uniting apparatus is very different from that of the vertebræ below.

Articulations of the Lower Five Cervical Vertebræ.—The lower five cervical vertebræ are united together very much upon the same plan as the vertebræ in other regions of the vertebral column. Both the bodies and the neural arches are connected by distinct articulations and special ligaments.

Three separate joints may be said to exist between the opposed surfaces of the *bodies* of two adjacent vertebræ—viz., a central amphiarthrodial joint and two small lateral diarthrodial joints.

The *amphiarthrodial joint* occupies by far the greatest part of the space which exists between the vertebral bodies, and it presents the usual characters of such an articulation. The opposed bony surfaces are coated by a thin layer of hyaline or encrusting cartilage, and are brought into direct union by an interposed disc of fibro-cartilage. The intervertebral discs are distinctly deeper in front than behind, and upon this the cervical curvature of the column in great measure depends.

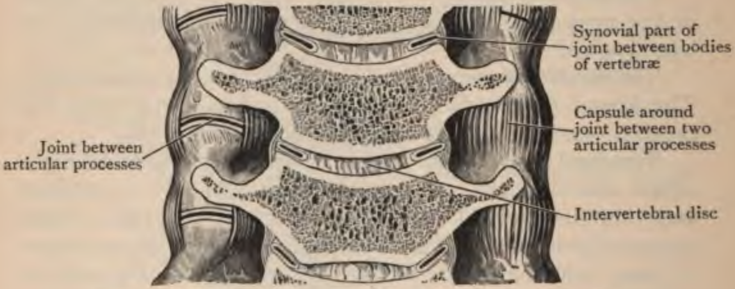

Synovial part of joint between bodies of vertebræ
Capsule around joint between two articular processes
Joint between articular processes
Intervertebral disc

FIG. 131.—Coronal section through bodies of certain of the Cervical Vertebræ.

The two *diarthrodial joints* are placed one on each side, where the disc of fibro-cartilage fails. They are of small extent, and are confined entirely to the intervals between the projecting lateral lips of the upper surface of the centrum, and the bevelled-off lateral margins of the lower surface of the vertebral body immediately above. Here the bony surfaces are coated with encrusting cartilage, and are separated by a synovial cavity protected on the outer side by a feeble capsular ligament.

The *ligaments* which bind the bodies of the five lower cervical vertebræ together are the direct continuation upwards of the anterior and the posterior common ligaments of the spine. In the removal of the spinal cord, the laminæ of the vertebræ below the axis have been taken away so that very little dissection will be required to make out the connexions of both of these ligaments. The *anterior common ligament* is a strong band placed in front of the vertebral bodies. It is more firmly fixed to the intervening intervertebral discs than to the bones. The *posterior common ligament* which lies on the posterior aspect of the vertebral bodies constitutes the anterior boundary of the spinal canal. In the cervical region it completely covers the bodies of the vertebræ, and does not present the denticulated appearance which is so characteristic of it lower down. It is chiefly attached to the cartilaginous discs and the adjacent margins of the bones.

The *neural arches* of the lower five cervical vertebræ are bound together by (*a*) the articulations between the articular processes; (*b*) ligamenta subflava; (*c*) by interspinous ligaments; and (*d*) intertransverse ligaments.

The *joints* between the opposing articular processes are of the diarthrodial variety. The surfaces of bone are coated with encrusting cartilage; there is a joint cavity lined by synovial membrane, and surrounded by a distinct capsular ligament. This ligament is more laxly arranged in the neck than in the lower regions of the spine.

The *ligamenta subflava* may be examined on the laminæ which were removed for the display of the spinal cord, and which the dissector was directed to retain. In this specimen they may be studied in the cervical, dorsal, and lumbar regions of the spine. They fill up the gaps between the laminæ of the vertebræ, and can be best seen when the fore aspect of the specimen is viewed.

The *ligamenta subflava* (ligamenta flava) are composed of yellow elastic tissue, and each ligament is attached superiorly to the anterior surface and inferior margin of the lamina of the vertebra above, whilst inferiorly it is fixed to the posterior surface and superior margin of the lamina of the vertebra next below. In this way they form with the laminæ a smooth, even posterior wall for the spinal canal. Each ligament extends from the posterior part of the articular processes to the mesial plane, where it is in contact by a free thickened inner border with its neighbour of the opposite side. The mesial slit between them in each interneural space is filled by some lax connective tissue, and it allows the egress from the spinal canal of some small veins. The width of the ligaments in the different regions of the spine depends upon the size of the spinal canal. Thus they are widest in the neck and in the lumbar part of the column. The ligamenta subflava, by virtue of their great strength and elasticity, are powerful agents in maintaining the curvatures of the spine; they also give valuable aid to the muscles in restoring the spine to its original position after it has been bent in a forward direction.

The *interspinous ligaments* are most strongly developed in the lumbar regions, where they fill up the intervals between the adjacent margins of contiguous spinous processes. In the dorsal region, and more especially in the neck, they are very weak.

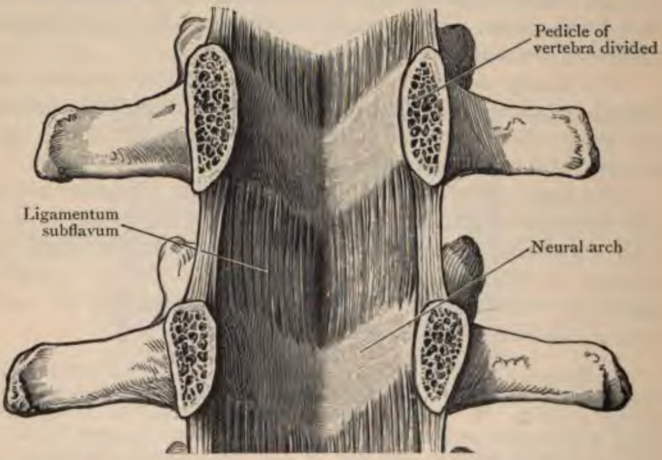


FIG. 132.—The Ligamenta Subflava in the Lumbar Region of Spine.

The *supraspinous ligaments* are thickened bands which connect the summits of the spinous processes. In the neck they are replaced by the ligamentum nuchæ (p. 147).

The *intertransverse ligaments* are feebly marked in the cervical region, and extend chiefly between the anterior bars of the transverse processes.

Articulations of the Axis, Atlas, and Occipital Bone.—The articulations which exist between these three bones all belong to the diarthrodial class. Between the atlas and axis there are three such joints—viz., a pair between the opposed articular processes, and a third between the anterior face of the odontoid process and the posterior face of the anterior arch of the atlas. Between the atlas and occipital bone there is a pair of joints—viz., between the occipital condyles and the elliptical cavities upon the upper aspect of the lateral masses of the atlas.

The ligaments connecting these three bones together may be divided into three main groups as follows :—

Ligaments connecting atlas with axis, ...	Anterior atlanto-axial.
	Posterior atlanto-axial.
	Capsular.
	Transverse portion of the cruciform ligament.
	Accessory ligaments of the atlanto-axial joints.
Ligaments connecting occipital bone with atlas, . .	Anterior occipito-atlantal.
	Posterior occipito-atlantal.
	Capsular.
Ligaments connecting occipital bone with axis, . .	Posterior occipito-axial.
	Appendices superior and inferior of the cruciform ligament.
	Alar odontoid or check.
	Suspensory.

The ligaments which are placed in relation to the exterior of the vertebræ should first be examined. These are the anterior and posterior atlanto-axial, and the anterior and posterior atlanto-occipital. The four capsular ligaments may also be more or less satisfactorily studied at the same time.

Anterior Atlanto-axial Ligament (Fig. 133).—This may be regarded as being a continuation upwards of the anterior common ligament of the spine. Below, it is attached to the fore aspect of the body of the axis, whilst above, it is fixed to the anterior arch of the atlas. It is thick and strong in the middle, but thins off towards the sides.

Posterior Atlanto-axial Ligament.—This ligament fills up the interval between the laminæ of the axis vertebra and the posterior arch of the atlas, to the contiguous margins of which it is attached. It is broad and membranous, and is the representative, as its attachments show, of the ligamenta subflava. It is pierced on each side by the second cervical nerve as this passes backwards over the neural arch of the axis.

Atlanto-axial Capsular Ligaments.—These are somewhat lax, and on removing the outer part of each, the joint cavities will be opened into.

Anterior Atlanto-Occipital Ligament (Fig. 133).—This ligament extends from the upper border of the anterior arch of the atlas to the under surface of the basilar process of the occipital bone in front of the foramen magnum. On each side of the mesial plane it is thin and membranous, and stretches outwards so as to abut against the atlanto-occipital capsular ligament. In the middle line there is an exceedingly strong cord-like band, which stands out in strong relief from the rest of the ligament, and is carried downwards to the anterior tubercle of the atlas. Part of its fibres are attached to this, but a certain proportion become continuous with the central thickening of the anterior atlanto-axial ligament, and through this with the anterior common ligament of the spine.

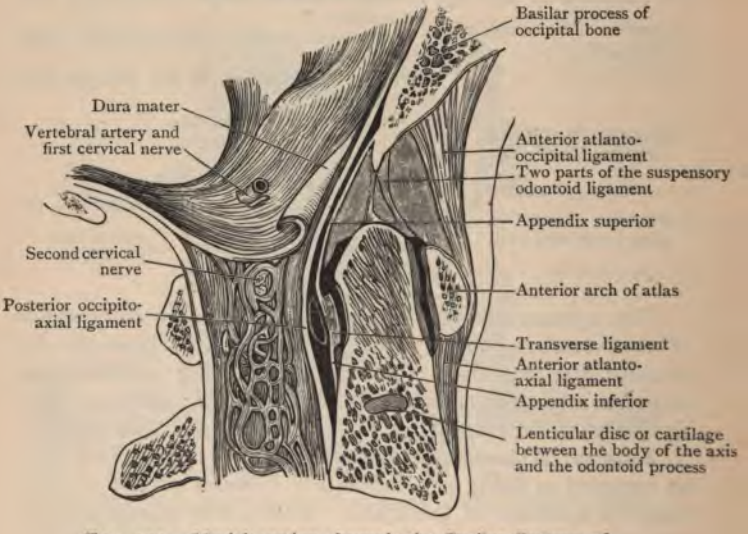

Basilar process of occipital bone
Dura mater
Vertebral artery and first cervical nerve
Anterior atlanto-occipital ligament
Two parts of the suspensory odontoid ligament
Appendix superior
Second cervical nerve
Anterior arch of atlas
Posterior occipito-axial ligament
Transverse ligament
Anterior atlanto-axial ligament
Appendix inferior
Lenticular disc or cartilage between the body of the axis and the odontoid process

FIG. 133.—Mesial section through the Basilar Process of Occipital Bone, the Atlas, and the Axis. (From Luschka, slightly modified.)

Between the posterior occipito-axial ligament and the transverse ligament a small synovial bursa may be seen.

Posterior Atlanto-Occipital Ligament.—This is a thin and weak membrane which occupies the gap between the posterior arch of the atlas and the posterior border of the foramen *magnum*, to both of which it is attached. It is very firmly connected with the dura mater, and on each side it reaches the atlanto-occipital capsular ligament. Over each of the grooves on the posterior arch of the atlas for the vertebral arteries it is deficient; here its lower border forms an arch, under which the vessel and the first cervical nerve pass. It is not uncommon to find this fibrous arch ossified.

Atlanto-Occipital Capsular Ligaments.—These connect the occipital condyles with the lateral masses of the atlas. They completely surround the joints, and are connected in front with the anterior atlanto-occipital ligament, and behind with the posterior atlanto-occipital ligament.

The occipital bone, therefore, round the foramen magnum is attached by special ligaments to each of the four portions of the atlas—viz., to the anterior arch, to the two lateral masses, and to the posterior arch.

Dissection.—The remaining ligaments are placed within the spinal canal in connexion with its anterior wall. For their proper display it is therefore necessary to remove with the bone pliers the laminæ of the axis, and the posterior arch of the atlas. The tabular part of the occipital bone must likewise be taken away by sawing it through, on each side, immediately behind the jugular eminence and the condyle, and carrying the saw into the foramen magnum. The upper part of the tube of dura mater which still remains in the spinal canal must next be carefully detached. A broad membranous band stretching upwards over the posterior aspect of the body and odontoid process of the axis is displayed. This is the posterior occipito-axial ligament or membrana tectoria.

Posterior Occipito-axial Ligament or the Membrana Tectoria.—This is a broad ligamentous sheet which is attached below to the posterior aspect of the body of the axis vertebra, where it is continuous with the posterior common ligament of the spine. It extends upwards, covering completely the odontoid process and the anterior margin of the foramen magnum, and is attached above to the posterior grooved surface of the basilar process of the occipital bone.

Dissection.—Detach this ligament from the axis and throw it upwards upon the basilar process of the occipital bone. By this proceeding the accessory ligaments of the atlanto-axial joints and the cruciform ligament are brought into view, and very little further dissection is required to define them.

Accessory Atlanto-axial Ligaments (Fig. 134).—These are two strong bands which take origin from the posterior aspect of the body of the axis vertebra close to the base of the odontoid process. Each band passes upwards and outwards, and is attached to the inner and hinder part of the lateral mass of the atlas. To a certain extent they assist the odontoid check ligaments in limiting the rotary movements of the atlas upon the axis.

Cruciform Ligament (ligamentum cruciatum) (Fig. 134).—The cruciform ligament is composed of a transverse and a vertical part. The *transverse ligament* (ligamentum transversum atlantis) is by far the most important constituent of this apparatus. It is a strong band which stretches from the tubercle on the inner aspect of the lateral mass of the atlas to the corresponding tubercle on the opposite side. With the anterior arch of the atlas it forms a ring which encloses the odontoid process—the pivot around which the atlas bearing the head turns. It is separated from the posterior aspect of the odontoid process by a loose synovial membrane which extends forward on each side until it almost reaches the synovial membrane in connexion with the mesial joint between the odontoid process and the anterior arch of the atlas. Indeed, in some cases a communication exists between the two synovial cavities.

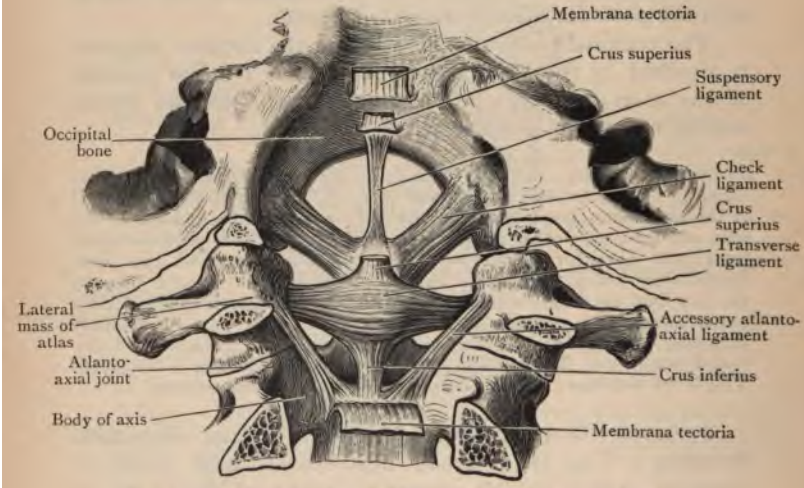

Membrana tectoria
Crus superius
Suspensory ligament
Occipital bone
Check ligament
Crus superius
Transverse ligament
Lateral mass of atlas
Accessory atlanto-axial ligament
Atlanto-axial joint
Crus inferius
Body of axis
Membrana tectoria

FIG. 134.—Dissection from behind of Ligaments connecting the Occipital Bone, the Atlas, and the Axis with each other.

The *vertical part* of the cruciform ligament consists of an upper and a lower limb, which are termed the appendices or crura. Both are attached to the dorsal surface of the transverse ligament. The *crus superius* is the longer and flatter of the two, and extends upwards on the posterior aspect of the head of the odontoid process to be attached to the posterior aspect of the basilar process immediately beyond the anterior margin of the foramen magnum. The *crus inferius*, much shorter, extends downwards, and is fixed to the posterior aspect of the body of the axis vertebra.

Dissection.—Detach the appendix superior from the basilar process, and throw it downwards. The suspensory ligament is thus displayed, and a better view of the alar or check ligaments obtained.

Suspensory Ligament (ligamentum apicis dentis).—The suspensory ligament of the odontoid consists of two parts—an anterior and a posterior. The *posterior part* is a rounded cord-like ligament which is attached below to the summit of the odontoid process, and above to the fore margin of the foramen magnum. This ligament, inasmuch as it is developed around the continuation of the chorda dorsalis from the odontoid to the basis cranii, is a structure of considerable morphological interest. The *anterior part* of the suspensory ligament is a flat and weak band which is attached above to the anterior margin of the foramen magnum at the same point as the posterior portion. Below, the two portions are separated by an interval filled with cellular tissue, and the anterior part is attached to the odontoid process immediately above its articular facet for the anterior arch of the atlas.

Check or **Alar Ligaments** (ligamenta alaria) (Fig. 134).—These are very powerful bands which spring, one from each side of the summit of the odontoid process, and proceed outwards and slightly upwards to be attached to the inner aspect of the condyloid eminences of the occipital bone. They limit rotation of the head, and in this they are aided by the accessory atlanto-axial ligaments.

Movements.—Nodding movements of the head are permitted at the occipito-atlantal articulations. Rotatory movements of the head and atlas around the odontoid process, which acts as a pivot, take place at the atlanto-axial joints. Excessive rotation is checked by the alar or check ligaments.

MOUTH AND PHARYNX.

The dissector must now return to the anterior part of the skull which had been laid aside while the dissection of the prevertebral region was being carried on. The mouth and pharynx should, in the first instance, engage his attention.

Mouth.—The mouth is the expanded upper part of the alimentary canal. It is placed in the lower part of the face, below the nasal chambers, and its cavity is controlled by muscles which are under the influence of the will. The mouth consists of two subdivisions, viz., a smaller anterior part, termed *the vestibule*, which is bounded in front by the lips and cheeks, and behind by the teeth and gums, and a large part, the *mouth proper*, which is placed within the teeth. The mucous lining of the mouth should be thoroughly cleansed, and the two subdivisions of the cavity examined from the front through the *oral fissure*.

The *vestibule* of the mouth which passes round the teeth and gums is a mere fissure-like space except when the cheeks are inflated with air. It is into this subdivision of the mouth that the parotid duct opens (p. 249). *Above* and *below*, it is bounded by the reflection of the mucous membrane from the lips and cheeks on to the alveolar margins of the maxillary and mandibular bones. In *front*, it opens upon the face by means of the oral fissure, whilst *posteriorly*, behind the last molar tooth, it communicates on each side by means of a variable aperture with the cavity of the mouth proper. When all the teeth are in place the existence of this communication is of importance in cases of spasmodic closure of the jaws, because through it fluids may be introduced into the posterior part of the buccal cavity or mouth proper.

In paralysis of the facial muscles the lips and cheeks fall away from the dental arcades and food is apt to lodge in the vestibule.

The *mouth proper* is that part of the buccal cavity which is placed within the teeth. It is bounded in front and laterally by the gums and teeth, whilst behind it communicates by means of the *isthmus faucium* with the pharynx. The *floor* is formed by the tongue and the mucous membrane which stretches to this from the inner aspect of the mandible; the *roof* is vaulted, and is composed of the hard and the soft palate. Into this part of the buccal cavity the ducts of the submaxillary glands (Wharton's ducts) and the ducts of the sublingual glands (ducts of Rivinus) open (pp. 301 and 302). When the mouth is closed the dorsum of the tongue is usually applied more or less closely to the palate, and the cavity is almost completely obliterated.

The various parts which bound the oral cavity may now be examined in turn.

Lips (labia oris).—The structure of the lips has in a great measure been already examined in the dissection of the face (p. 258). Each lip may be regarded as being composed of four layers. From before backwards these are—(1) cutaneous; (2) muscular; (3) glandular; and (4) mucous. The *skin* and *mucous membrane* become continuous with each other at the free margin of the lip. From the deep aspect of each lip the mucous membrane is reflected on to the alveolar margin of the corresponding jaw, and in the mesial plane it is raised in the form of a free fold. These folds are termed the *frenula*; in the dissection of the face they have been more or less destroyed. The *muscular layer* constitutes the chief bulk of the lips. It is formed by the orbicularis oris and the various muscles which converge upon the mouth, many of the fibres of which are attached to the skin. The *labial glands* are very numerous, and lie in the submucous tissue which intervenes between the mucous membrane and the muscular fibres. The ducts of these glands pierce the mucous membrane, and open into the vestibule. In each lip there is an arterial arch formed by the corresponding coronary arteries (p. 268).

The lymphatic vessels of both lips join the submaxillary lymphatic glands. This has an important bearing in connexion with epithelioma of the lip.

Cheeks (buccæ).—The cheeks have five layers entering into their construction, all of which have been examined in the dissection of the face. They are—(1) skin; (2) a fatty layer traversed by some of the facial muscles and the facial artery; (3) the buccal aponeurosis; (4) the buccinator muscle; (5) the mucous membrane. Numerous *buccal glands*, similar in character to the labial glands, lie in the submucous tissue between the mucous membrane and the buccinator muscle. Four or five mucous glands of larger size, termed the *molar* *glands*, occupy a more superficial position. They lie upon the buccal aponeurosis, close to the point where this is pierced by the parotid duct, and their ducts also open into the vestibule of the mouth. The *buccal aponeurosis* is a dense fascia which covers the buccinator muscle. Above and below, it is attached to the alveolar portions of the maxillary and mandibular bones, whilst behind, it is continued backwards upon the side of the pharynx. The muscles which traverse the *fatty layer* are chiefly the zygomaticus major, the risorius, and the posterior fibres of the platysma. The parotid duct pierces the three inner layers of the cheek, and opens into the vestibule of the mouth opposite the second molar tooth of the upper jaw.

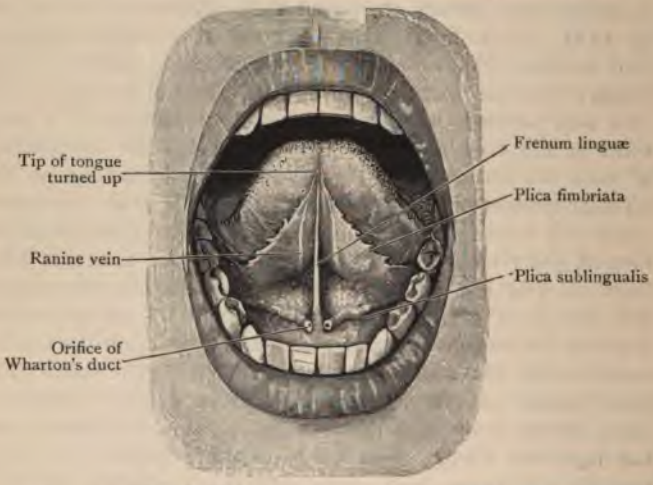


FIG. 135.—The Sublingual Region in the Interior of the Mouth.

Gums and Teeth.—The mucous membrane of the gums is smooth, vascular, and firmly bound down to the subjacent periosteum of the alveolar portions of the jaws by a stratum of dense connective tissue. It is continuous on the one hand with the mucous membrane of the lips and cheeks, and on the other with the mucous membrane of the floor of the mouth. The gum embraces closely the neck of each tooth.

In the adult the teeth in each jaw number sixteen. From the middle line backwards, on each side, they are the two incisors, the canine, the two bicuspids, the three molars.

Floor of the Mouth.—The mucous membrane is reflected from the inner aspect of the lower jaw, on to the side of the tongue, but in the fore-part of the mouth the tongue lies more or less free in the buccal cavity. Here the mucous membrane stretches across the floor from one side of the lower jaw to the other. On each side of this region the projection formed by the sublingual gland can be distinguished. Further, if the tongue be pulled upwards, a mesial fold of mucous membrane will be seen to connect its under surface to the floor. This is the *frenum linguæ.* The dissector must also look for the openings of Wharton's ducts. Each terminates in a papillary orifice placed close to the side of the frenum. Farther back, between the side of the tongue and the jaw, and on the summit of the plica sublingualis, are the openings of the ducts of Rivinus.

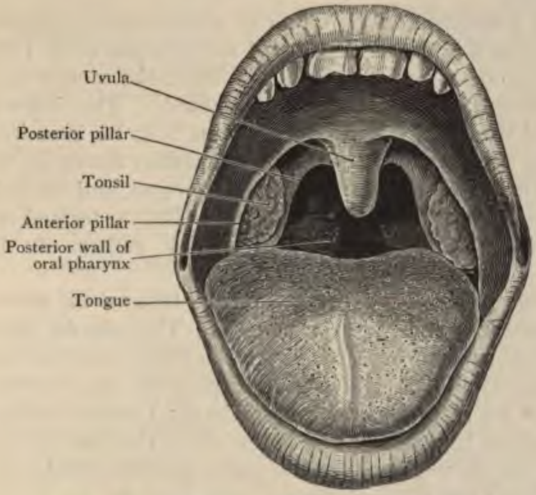


FIG. 136.—Isthmus of the Fauces as seen through the widely opened Mouth. The tonsils in the individual from which this drawing was taken were somewhat enlarged.

Roof of the Mouth.—The hard and the soft palate form the continuous concave and vaulted roof of the mouth (Fig.

138). Projecting from the middle of the posterior free margin of the soft palate, and resting upon the dorsum of the tongue, will be seen the *uvula* (Fig. 136). The palate both hard and soft is traversed by a median ridge or raphe which terminates in front, opposite the anterior palatine foramen, in a slight elevation or papilla termed the *incisive pad* or *palatine papilla.* In the anterior part of the hard palate the mucous membrane on each side of the raphe is thrown into three or four transverse hard corrugations or ridges; behind this it is comparatively smooth.

Isthmus Faucium.—This name is given to the communication between the buccal cavity and the pharynx (Fig. 136). To obtain a good view of it from the front, the mouth must be well opened and the tongue depressed. The isthmus faucium and the parts which bound it can best be examined in the living subject (Fig. 136). It is bounded above by the soft palate, below by the dorsum of the tongue, and on each side by two curved folds of mucous membrane, termed respectively the anterior and the posterior pillars of the fauces.

The *pillars of the fauces* spring from the base of the uvula, and arch outwards and then downwards. The *anterior pillar* (arcus glossopalatinus) as it descends inclines forwards, and ends upon the side of the posterior part of the tongue; the *posterior pillar* (arcus pharyngopalatinus), more strongly marked, inclines backwards, and is lost upon the side of the pharynx. The former encloses the palato-glossus muscle, the latter the palato-pharyngeus muscle.

In the triangular interval which is formed by the divergence of these two folds will be observed the *tonsil.*

Strictly speaking, the term *isthmus faucium* should be confined to the interval between the two anterior palatine arches, as the tonsil and the posterior palatine arches belong to the lateral wall of the pharynx.

Pharynx.—The pharynx is a wide musculo-aponeurotic canal about 5 inches long, which extends from the base of the cranium to the level of the body of the sixth cervical vertebra. Here at the lower border of the cricoid cartilage it becomes continuous with the œsophagus. Placed behind the nasal cavities, the mouth and the larynx, it serves as the passage which conducts air to and from the larynx, as well as the food from the mouth to the œsophagus.

To obtain a proper idea of the connexions of the pharynx, the dissector should moderately distend its walls by stuffing it with tow. This may be introduced either from above, through the mouth, or from below, through the œsophagus.

The pharynx will now present a somewhat ovoid form. It is widest opposite the hyoid bone; from this upwards it narrows slightly as it ascends to the basis cranii. When traced in an opposite direction its width diminishes rapidly and uniformly, until it gives place to the œsophagus. *Posteriorly* its wall is complete, and when in position rests upon the upper five cervical vertebræ, the prevertebral muscles, and the prevertebral fascia. To these it is bound by some lax connective tissue which offers no barrier to the movements of the canal during the process of deglutition. *Laterally* the pharynx is related to the great vessels and nerves of the neck as well as to the styloid process and the muscles which take origin from it. Upon this aspect of the pharynx also is placed the pharyngeal plexus of nerves, which supplies its walls with motor and sensory twigs. *In front* the pharyngeal wall is interrupted by the openings of the nasal chambers, mouth, and larynx, and it is from the structures which lie in proximity to these apertures that it derives its principal attachments. Thus from above downwards it is fixed—(*a*) to the internal pterygoid plate; (*b*) to the pterygo-maxillary ligament; (*c*) to the side of the tongue; (*d*) to the inner aspect of the mandible; (*e*) to the hyoid bone; (*f*) to the thyroid cartilage; (*g*) to the cricoid cartilage. *Above*, it is attached to the basis cranii. These various attachments will be studied more fully when we dissect the constituents which enter into the construction of its wall.

It should be noted that an altogether false idea of the natural form of the pharynx is obtained when it is examined in its present stuffed condition and apart from the vertebral column, against which it rests. When seen in transverse sections of the frozen body it will be observed that with the exception of its upper or nasal part, which remains patent under all conditions, the anterior wall is more or less nearly approximated to the posterior wall, and below the opening of the larynx it presents the appearance of a simple transverse slit.

Pharyngeal Wall.—The wall of the pharynx may be said to consist of three well-marked strata—viz., an external muscular, an intermediate aponeurotic, and an internal mucous. The muscular layer, which is composed of the three constrictor muscles, with the stylo-pharyngeus and palato-pharyngeus on each side, should first be dissected.

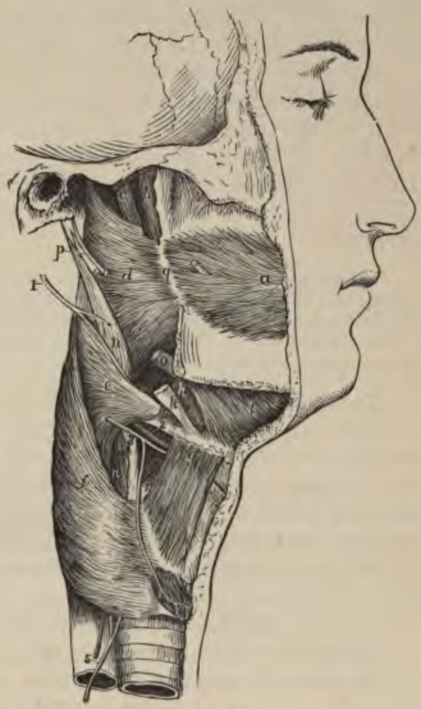
For this purpose, place the preparation so that the chin rests upon a block, and the pharynx hangs downwards with its posterior surface towards the dissector. The constrictor muscles should now be carefully cleaned in the direction of the muscular fibres, by removing the bucco-pharyngeal fascia which covers them.

Bucco-pharyngeal Fascia.—This coating is sometimes spoken of under the name of the *tunica pharyngis externa*; more frequently, however, it is called the *bucco-pharyngeal fascia*, seeing that it is continuous in front with the buccal aponeurosis. This fascial investment must not be confounded with the prevertebral layer of cervical fascia which forms a distinct lamina behind it. The bucco-pharyngeal and the prevertebral layers of fascia are separated from each other by an interval occupied by lax connective tissue, and which, from the ease with which fluids can travel within it, is called the *retro-pharyngeal space*. Both layers of fascia are connected laterally with the carotid sheath.

Pharyngeal Veins.—Upon the posterior and lateral walls of the pharynx the dissector will not fail to notice numerous veins joined together in a plexiform manner. These constitute the *pharyngeal venous plexus*, which collects blood from the pharynx, soft palate, and prevertebral region, and communicates with the pterygoid plexus. Two or more channels lead the blood from it to the internal jugular vein. This venous plexus, together with the pharyngeal plexus of nerves, will require to be removed in order to display the muscles properly.

Constrictor Muscles.—The constrictor muscles are three flat sheets of muscular fibres which are so arranged that they overlap each other from below upwards; thus the inferior constrictor overlaps the lower part of the middle constrictor, whilst the middle constrictor in turn overlaps the lower part of the superior constrictor. The three muscles are inserted in the mesial plane into the median raphe, which descends from the basilar process of the occipital bone along the posterior aspect of the pharynx.

The *inferior constrictor* (musculus constrictor pharyngis inferior) (Fig. 137, *f*) is narrow in front at its origin, but it spreads out as it passes backwards towards its insertion. It arises by two heads; of these the *lower* springs from the posterior part of the side of the cricoid cartilage, whilst the *upper* and larger head takes origin from the inferior cornu, the oblique line of the ala, and the upper border of the thyroid cartilage. The muscle curves backwards round the pharyngeal wall to meet its fellow of the opposite side in the median raphe. The lower fibres take a horizontal direction, but the remainder ascend with increasing degrees of obliquity, until the highest fibres reach the raphe at a point a short distance below the basis cranii. The lower margin of the inferior constrictor overlaps the commencement of the œsophagus, and passing upwards under cover of it, so as to



a. Buccinator.
b. Tensor palati.
c. Levator palati.
d. Superior constrictor.
e. Middle constrictor.
f. Inferior constrictor.
g. Thyro-hyoid.
h. Hyoglossus.
k. Stylo-hyoid.
l. Mylo-hyoid.
m. Crico-thyroid.
n. Stylo-pharyngeus.
o. Stylo-glossus.
p. Stylo-hyoid ligament.
q. Pterygo-maxillary ligament.
1. Glosso-pharyngeal nerve.
2. Superior laryngeal artery.
3. Superior laryngeal nerve.
4. External laryngeal nerve.
5. Inferior laryngeal nerve and artery.

FIG. 137.—Profile view of the Pharynx to show the Constrictor Muscles. (From Turner.)

reach the larynx, will be seen the recurrent laryngeal nerve and the laryngeal branch of the inferior thyroid artery.

The *middle constrictor* (musculus constrictor pharyngis medius) is a fan-shaped muscle (Fig. 137, *e*). Narrow, and pointed in front, it arises from the great and small cornua of the hyoid bone as well as from the stylo-hyoid ligament. From this its fibres radiate widely, and pass round the pharyngeal wall, to be inserted with the corresponding fibres of the opposite side into the median raphe. The lower portion of this muscle is overlapped by the inferior constrictor, and in the interval which separates the margins of the muscles in front, the internal laryngeal nerve and the laryngeal branch of the superior thyroid artery will be seen piercing the thyro-hyoid membrane to gain the interior of the larynx.

Dissection.—The superior constrictor possesses a somewhat complicated origin, and to bring this fully into view it will be necessary to cut through the internal pterygoid muscle about its middle, and turn the upper and lower portions aside. In doing this, be careful of the small tensor palati muscle which lies immediately subjacent to the internal pterygoid.

The *superior constrictor* (musculus constrictor pharyngis superior) (Fig. 137, *d*) has a weak but continuous line of origin from the following parts—viz., (*a*) the lower third of the posterior border of the internal pterygoid plate, and the hamular process; (*b*) the pterygo-maxillary ligament which is common to it, and the buccinator muscle; (*c*) the posterior end of the mylo-hyoid ridge on the inner aspect of the mandible; (*d*) the mucous membrane of the mouth, and side of the tongue. From this somewhat extensive origin, the fibres curve backwards to reach the median raphe, whilst, as a rule, some of the highest gain a distinct insertion into the pharyngeal tubercle, on the under surface of the basi-occipital bone.

The lower part of the superior constrictor is overlapped by the middle constrictor, and in the interval between the two muscles will be seen the stylo-pharyngeus as it passes downwards under cover of the middle constrictor (Fig. 137, *n*). In the same interval will be seen the glosso-pharyngeal nerve. The upper border of the muscle is free and crescentic, and it falls short of the basis cranii.

Pterygo-maxillary Ligament (Fig. 137, *q*).—This is a strong, narrow, tendinous band, which extends from the hamular process of the internal pterygoid plate, to the posterior part of the mylo-hyoid ridge of the mandible. It acts as a tendinous bond of union between the buccinator and superior constrictor muscles, and its connexions can be best appreciated by introducing the finger into the mouth and pressing outwards along its course.

Sinus of Morgagni.—This name is applied to the semilunar space which intervenes between the upper crescentic margin of the superior constrictor and the basis cranii. The deficiency in the muscular wall of the pharynx at this point is compensated for by the increased strength of the pharyngeal aponeurosis. In contact with the outer surface of the aponeurosis, a little dissection will display two muscles belonging to the soft palate—viz., the *levator palati* and the *tensor palati* (Fig. 137, *c* and *b*). The levator is rounded and fleshy, and lies behind the tensor, which is flatter and more tendinous. The latter can readily be recognised, from its position in relation to the deep surface of the internal pterygoid muscle, and from its tendon turning inwards under the hamular process. In the upper part of the space, close to the basis cranii, and in intimate relationship to the origin of the two muscles, will be seen the *Eustachian tube.*

Pharyngeal Aponeurosis.—The pharyngeal aponeurosis is strongly marked in its upper part, and maintains the integrity of the wall of the pharynx where the muscular fibres are absent. As it is traced downwards it gradually becomes weaker, until it is ultimately lost as a distinct layer. It lies between the muscles and mucous membrane, and only comes to the surface where the muscles are absent. It is the principal means by which the pharynx is attached to the base of the skull. It is also united to the Eustachian tubes and the bony margins of the posterior nares.

Dissection.—The pharynx should now be opened by a vertical and mesial incision through the entire length of the posterior wall. At the upper extremity of this cut, the knife should be carried transversely outwards, close to the basis cranii, so as to divide the attachment of the posterior wall to the basi-occipital bone. The stuffing should be removed and the mucous surface of the pharynx cleansed.

Interior of the Pharynx.—The *mucous membrane*, or innermost stratum which enters into the construction of the pharyngeal wall, is now exposed, and it should be observed that it is continuous, through the various apertures which open into the pharynx, with the mucous membrane of the *nasal chambers*, of the *Eustachian tubes* and *tympanic cavities*, of the *buccal cavity*, of the *larynx*, and of the *œsophagus*.

Racemose glands, which lie immediately subjacent to the mucous membrane and which secrete mucus, are present in great numbers. There are also numerous *lymphoid follicles*, and in certain localities these are aggregated together into large masses (the tonsils and the pharyngeal tonsil), which will require to be studied with the section of the pharynx in *relation to* which they are placed.

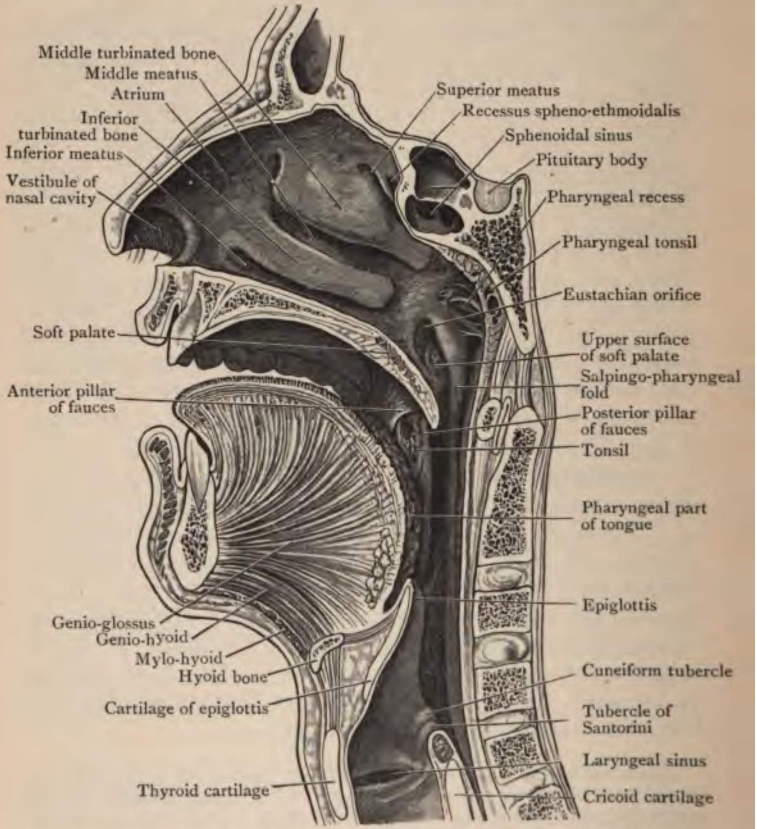

Middle turbinated bone
Middle meatus
Atrium
Inferior turbinated bone
Inferior meatus
Vestibule of nasal cavity
Soft palate
Anterior pillar of fauces
Genio-glossus
Genio-hyoid
Mylo-hyoid
Hyoid bone
Cartilage of epiglottis
Thyroid cartilage
Superior meatus
Recessus spheno-ethmoidalis
Sphenoidal sinus
Pituitary body
Pharyngeal recess
Pharyngeal tonsil
Eustachian orifice
Upper surface of soft palate
Salpingo-pharyngeal fold
Posterior pillar of fauces
Tonsil
Pharyngeal part of tongue
Epiglottis
Cuneiform tubercle
Tubercle of Santorini
Laryngeal sinus
Cricoid cartilage

FIG. 138.—Sagittal section through the Nasal Chamber, the Mouth, Larynx, and Pharynx, a little to the right of the mesial plane.

The soft palate, which projects backwards into the pharynx behind the isthmus faucium like a curtain, divides the cavity of the pharynx into an upper and a lower part. The *upper part*, called the *naso-pharynx*, is brought into communication with the nasal chambers and the tympanic cavities by four apertures, viz., the two choanæ or posterior nares and the mouths of the two Eustachian tubes.

The *lower portion* of the pharynx may be regarded as consisting of an *oral part*, which lies behind the mouth and tongue, and a *laryngeal* part, which is placed behind the larynx. Below the soft palate there are three mesial openings into the pharynx, viz., the *opening of the mouth* or *isthmus faucium*, the *opening of the larynx*, and the *opening of the œsophagus*.

Naso-Pharynx (pars nasalis).—The naso-pharynx is situated immediately behind the nasal chambers and below the body of the sphenoid and the basilar part of the occipital bone. It is the widest part of the pharynx. Its walls are not capable of movement, and consequently its cavity always remains patent, and presents under all conditions very much the same form.

The *front wall* of the naso-pharynx is deficient. Here the *posterior nares* or *choanæ* open directly into the naso-pharynx. These are two large oval apertures which constitute the communication between the nasal fossæ and the pharynx. They are separated from each other by the thin posterior border of the vomer bone. The vertical diameter of each opening measures about one inch, whilst the transverse diameter at its widest part is about half an inch. By looking through the posterior nares a partial view of the two lower meatuses of the nose and of the posterior ends of the middle and inferior turbinated bones may be obtained.

On the *lateral wall* of the naso-pharynx, on each side, is seen the orifice of the Eustachian tube, and behind this the pharyngeal recess. The *Eustachian orifice* (ostium pharyngeum) is placed behind the lower part of the choana at a level which corresponds closely with the posterior end of the inferior turbinated bone. It is bounded above and behind by a high prominent and rounded margin termed the *Eustachian cushion* (torus tuberius), which is altogether deficient below and in front. A fold of mucous membrane, termed the *salpingo-pharyngeal fold*, descends upon the lateral wall of the pharynx from the posterior part of the Eustachian cushion. As this is traced downwards it gradually disappears. The prominent posterior part of the Eustachian cushion favours very materially the passage of the Eustachian catheter.[1]

In the natural condition of parts there is a deep slit-like recess on the lateral wall of the naso-pharynx immediately behind the prominent posterior lip of the Eustachian orifice. This is termed the *lateral recess* of the pharynx, or the *fossa of Rosenmüller*, and it possesses considerable interest from a developmental point of view.

The *roof* and *posterior wall* of the naso-pharynx are not marked off from each other. They together form a continuous curved surface. The upper portion of this surface looks downwards and may be regarded as the roof; the lower portion which looks forwards constitutes the posterior wall. The *roof* is formed by the basilar part of the occipital bone, and also by a small part of the under surface of the basi-sphenoid covered by a dense periosteum and a thick coating of mucous membrane. The *posterior wall* is supported behind by the anterior arch of the atlas and the odontoid process of the axis vertebra. In that part of the roof which stretches across between the two lateral recesses of the naso-pharynx there is a marked collection of lymphoid tissue, and over its surface the mucous membrane is thickened and wrinkled. This is the *pharyngeal tonsil*, and in its lower part there will usually be found a small median pit termed the *pharyngeal bursa*, just large enough to admit the point of a fine probe.

The *floor* of the naso-pharynx is formed by the curved, sloping upper surface of the soft palate. Between the lower border of the soft palate and the posterior wall of the pharynx there is an interval termed the *pharyngeal isthmus*, through which the naso-pharynx communicates with the oral pharynx.

It is important to note that the posterior wall and roof of the naso-pharynx can be explored by the finger, introduced through the mouth and the pharyngeal isthmus.

When the naso-pharynx is illuminated by a mirror introduced through the mouth, a view of the four orifices which open into this part of the pharynx may be obtained. Owing to the mirror being placed obliquely and below the level of the hard palate, only the hinder parts of the inferior turbinated bones are visible through the choanæ, and the inferior meatus of the nose is altogether out of sight. The middle and superior meatuses of the nose, and the middle and superior turbinated bones, however, can be brought into view and their condition ascertained. The lateral wall of the naso-pharynx and the Eustachian orifice can also be fully inspected.

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[1] A Eustachian catheter can be very readily improvised by bending the extremity of an ordinary blow-pipe. The dissector is recommended to practise the passage of this instrument into the Eustachian tube through the nose.

Oral Pharynx (pars oralis).—The oral pharynx lies behind the tongue and mouth. The pharyngeal part of the tongue which looks more or less directly backwards forms its *anterior wall* in its lower part. Above this is the isthmus of the fauces, or the opening into the mouth, limited on either side by the anterior pillar of the fauces. These pillars may be regarded, therefore, as giving the lateral boundary lines between the mouth and the pharynx. On the *lateral wall* of the oral pharynx the posterior pillar of the fauces forms a prominent fold which is gradually lost as it is traced downwards. Within this fold is the palato-pharyngeus muscle. This is an important relation when it is remembered that the posterior pillars of the fauces form the lateral boundaries of the pharyngeal isthmus. By the contraction of the palato-pharyngeal

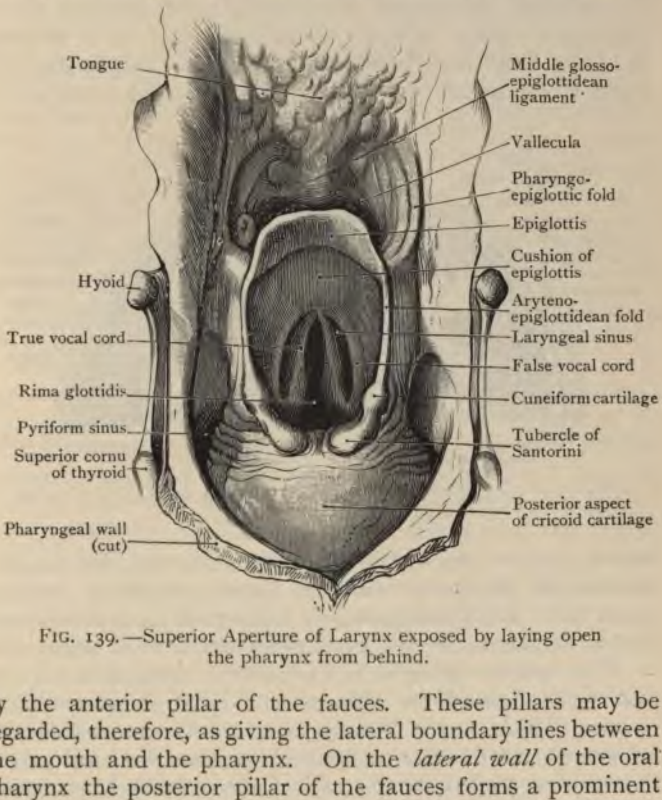
Tongue
Hyoid
True vocal cord
Rima glottidis
Pyriform sinus
Superior cornu of thyroid
Pharyngeal wall (cut)
Middle glosso-epiglottidean ligament
Vallecula
Pharyngo-epiglottic fold
Epiglottis
Cushion of epiglottis
Aryteno-epiglottidean fold
Laryngeal sinus
False vocal cord
Cuneiform cartilage
Tubercle of Santorini
Posterior aspect of cricoid cartilage

FIG. 139.—Superior Aperture of Larynx exposed by laying open the pharynx from behind.

muscles the two posterior pillars can be approximated so as to greatly reduce the width of the pharyngeal isthmus.

The anterior and posterior pillars of the fauces form on each lateral wall of the oral pharynx the limits of a triangular interval in which is lodged the tonsil. The upper part of this area, above the level of the tonsil, presents a small depression termed the *supra-tonsillar fossa.*

Laryngeal part of the Pharynx (pars laryngea).—The portion of the pharyngeal cavity which lies behind the larynx diminishes rapidly in width in its lower part so as to bring its lumen into conformity with that of the œsophagus, with which it is continuous. In its front wall from above downwards may be seen: (1) the epiglottis; (2) the superior aperture of the larynx with the pyriform fossa or sinus on either side; and (3) the posterior surfaces of the arytenoid and cricoid cartilages, covered by muscles and mucous membrane.

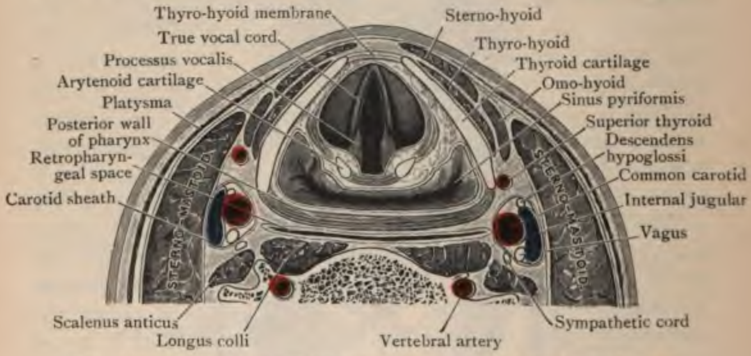
Thyro-hyoid membrane
True vocal cord
Processus vocalis
Arytenoid cartilage
Platysma
Posterior wall of pharynx
Retropharyngeal space
Carotid sheath
Scalenus anticus
Longus colli
Sterno-hyoid
Thyro-hyoid
Thyroid cartilage
Omo-hyoid
Sinus pyriformis
Superior thyroid
Descendens hypoglossi
Common carotid
Internal jugular
Vagus
Sympathetic cord
Vertebral artery
STERNO-MASTOID
STERNO-MASTOID

FIG. 140.—Transverse section through the Neck at the level of upper part of Thyroid Cartilage.

The *superior aperture of the larynx*, situated below the pharyngeal part of the tongue, is a large obliquely placed opening which slopes rapidly from above downwards and backwards. Somewhat triangular in outline, the basal part of the opening, placed above and in front, is formed by the free border of the epiglottis. Behind, the opening rapidly narrows, and finally ends in the interval between the two arytenoid cartilages. The sides of the aperture are formed by two sharp and prominent folds of mucous membrane, termed the *aryteno-epiglottidean folds*, which stretch between the lateral margins of the epiglottis in front and the arytenoid cartilages behind. Two small nodules of cartilage in the hinder part of the aryteno-epiglottidean fold give rise to two rounded eminences, called respectively the *cuneiform tubercle* in front and the *tubercle of Santorini* behind.

On either side of the lower part of the laryngeal opening there is a small three-sided or pyramidal recess or depression, called the *sinus pyriformis*. On the outer side it is bounded by the posterior part of the ala of the thyroid cartilage; on the inner side by the arytenoid cartilage; whilst its hinder wall is formed by the posterior wall of the pharynx when this is in place. The sinus pyriformis presents a wide entrance which looks upwards, but it rapidly narrows towards the bottom (Figs. 139 and 140), and it is important to the surgeon because it is in this little pocket that foreign bodies introduced into the pharynx are most liable to be caught.

Below the opening of the larynx, the anterior and posterior walls of the pharynx are always closely applied to each other, except during the passage of food.

The *œsophageal opening* is placed opposite the lower border of the cricoid cartilage. This is the narrowest part of the pharynx.

Soft Palate (velum palatinum).—The soft palate is a movable curtain, which projects downwards and backwards into the pharynx. During deglutition, it is raised so as to shut off the upper nasal part of the pharynx from the portion below, and at the same time open up the isthmus faucium. In *front* it is attached to the posterior margin of the hard palate; *on each side* it is connected with the lateral wall of the pharynx; whilst *posteriorly* it presents a free border. From the centre of this free margin the conical elevation termed the *uvula* projects, whilst the sharp concave part of the border on either side of the uvula becomes continuous with the posterior palatine arch which descends on the side wall of the pharynx. The *upper surface* of the soft palate is convex and continuous with the floor of the nasal fossæ; the *inferior surface* is concave and continuous with the vaulted roof of the mouth. The anterior palatine arch curves outwards from this surface of the soft palate a short distance in front of its posterior free border. Upon the inferior surface may be seen a slightly marked mesial ridge or raphe.

The soft palate is composed of a fold of mucous membrane, between the two layers of which are interposed muscular, aponeurotic, and glandular structures, together with blood-vessels and nerves.

Palatal muscles, .	The two levatores palati. The two tensores palati. The two palato-glossi. The two palato-pharyngei. The azygos uvulæ.	
Palatal aponeurosis.		
Palatal glands.		
Arteries, .	Ascending palatine from facial. Palatine branch from ascending pharyngeal. Twigs from the descending palatine branch of the internal maxillary.	
Nerves, .	Small posterior palatine, . External posterior palatine, .	from the spheno-palatine ganglion.

The *racemose mucous glands* in the soft palate form a very thick and continuous layer immediately subjacent to the mucous membrane which clothes its inferior surface. Close to the posterior border of the hard palate the soft palate contains very few muscular fibres, and here it is chiefly composed of the two layers of mucous membrane enclosing the glands, and above these the palatal aponeurosis.

Dissection.—The dissection of the soft palate is difficult, and it is only in a fresh part that the precise relations of the different muscular layers can be made out. Begin by rendering it tense by means of a hook, and then remove carefully the mucous membrane from its upper and lower surfaces, and also from the anterior and posterior pillars of the fauces. The latter proceeding will expose the palato-glossus and the palato-pharyngeus muscles on each side.

Palato-glossus (musculus glosso-palatinus).—The palato-glossus is a delicate muscular slip, which arises from the side of the posterior part of the tongue, and curves upwards and inwards to reach the under surface of the soft palate above the glandular layer. Here its fibres spread out, and become continuous with the corresponding fasciculi of the opposite side. It forms the lowest muscular stratum of the soft palate.

Palato-pharyngeus (musculus pharyngo-palatinus).—The palato-pharyngeus forms two muscular strata in the soft palate which enclose between them the azygos uvulæ and the levator palati muscles. The *upper layer* is very weak, and confined to the posterior part of the velum. It constitutes the most superficial muscular stratum on this aspect of the palate, and becomes continuous with the corresponding portion of the muscle of the opposite side. The *deeper layer* takes origin from the posterior margin of the palate bone and from the palatal aponeurosis, while some of its fibres mingle with those of the corresponding muscle of the opposite side. Outside the soft palate the two strata come together, and are joined by one or two delicate muscular slips which spring from the lower border of the cartilage of the Eustachian tube. These slips are sometimes described as the *salpingo-pharyngeus muscle*. The palato-pharyngeus thus formed arches downwards and backwards in the posterior pillar of the fauces, and spreads out into a thin sheet of fibres in the wall of the pharynx. Blending to some extent with the stylo-pharyngeus, it is inserted into the superior and posterior borders of the thyroid cartilage. Some of its fibres, however, incline backwards, and are inserted into the pharyngeal aponeurosis.

Azygos Uvulæ (musculus uvulæ).—This delicate muscle is placed on the upper aspect of the soft palate, and posteriorly it is covered by the superficial fibres of the palato-pharyngeus. These must be removed to expose it fully. It consists of two minute slips which, as a rule, arise from the posterior nasal spine of the hard palate, and lie one on either side of the mesial plane. As they proceed backwards into the uvula they unite into a single rounded muscular belly.

Dissection.—The levator palati muscle has already been seen on the outer aspect of the pharynx in the sinus of Morgagni. To display it fully it is necessary to remove the wall of the pharynx between the Eustachian tube above and the upper border of the superior constrictor below, and then follow its fibres into the soft palate. In a well-injected subject the dissector will observe the ascending palatine artery in relation to this muscle.

Levator Palati (musculus levator veli palatini).—The levator palati is a rounded fleshy muscle which arises from the lower and inner border of the cartilage of the Eustachian tube, and from the rough surface on the under aspect of the apex of the petrous bone in front of the carotid canal. It passes downwards and forwards, crosses the upper border of the superior constrictor, and piercing the pharyngeal aponeurosis enters the soft palate. Here its fibres spread out below the azygos uvulæ and above the anterior or deep portion of the palato-pharyngeus. In front, some of the fibres are inserted into the palatal aponeurosis; but behind this, the larger proportion of the fibres become continuous with the corresponding fasciculi of the opposite side.

Tensor Palati (musculus tensor veli palatini).—This little aponeurotic, and glandular structures, together with blood-vessels and nerves.

Palatal muscles, .	The two levatores palati. The two tensores palati. The two palato-glossi. The two palato-pharyngei. The azygos uvulæ.	
Palatal aponeurosis.		
Palatal glands.		
Arteries, .	Ascending palatine from facial. Palatine branch from ascending pharyngeal. Twigs from the descending palatine branch of the internal maxillary.	
Nerves, .	Small posterior palatine, . External posterior palatine, .	from the spheno-palatine ganglion.

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Tensor Palati (musculus tensor veli palatini).—This little muscle lies in front of the levator palati. It is flat and band-like, and closely applied to the deep surface of the internal pterygoid muscle. It arises from the scaphoid fossa at the root of the internal pterygoid plate, from the spine of the sphenoid, and from the outer aspect of the Eustachian tube. It descends perpendicularly and ends in a tendon which turns horizontally inwards under the hamular process. A synovial bursa facilitates the play of the tendon upon the bone. In the soft palate the tendon expands below the deep part of the palato-pharyngeus, and is inserted partly into the transverse ridge on the under surface of the horizontal plate of the palate bone, and partly into the palatal aponeurosis with which it blends.

Palatal Aponeurosis.—The palatal aponeurosis extends backwards from the posterior margin of the hard palate to give strength and support to the soft palate. At first it is strongly marked, but it very soon becomes lost as it is traced back into the soft palate. The small portion of the soft palate which it supports contains few muscular fibres, and remains always more or less horizontal in position. The much more extensive hinder muscular part of the soft palate constitutes the movable sloping portion. The tensor palati operates upon the anterior aponeurotic portion of the soft palate.

Vessels and Nerves of the Soft Palate.—The *inferior* or *ascending palatine branch* of the facial is, as a rule, the principal artery of supply to the soft palate. It has already been traced to the outer wall of the pharynx (pp. 237 and 309). Here it is seen in the sinus of Morgagni, in relation to the levator palati muscle which it accompanies into the soft palate. The *palatine branch* of the ascending pharyngeal artery may also be traced into the soft palate. In cases where the preceding artery is small, this twig will be found enlarged so as to take its place (p. 310). The *descending palatine branch* of the internal maxillary artery likewise sends small twigs to the soft palate and tonsil.

Two nerves enter the soft palate from Meckel's ganglion—viz., the *small posterior palatine* and the *accessory posterior palatine nerve*. It would appear, however, that they do not supply the muscles, but are distributed to the mucous membrane. The levator palati, the azygos uvulæ, the palato-glossus, and the palato-pharyngeus are supplied by twigs from the pharyngeal branches of the vagus, which convey to them fibres which are originally derived from the accessory part of the spinal accessory (*v.* p. 318)

(W. Aldren Turner). The tensor palati is probably supplied by the branch which it receives from the otic ganglion, and which probably leads to it fibres which originally come from the motor part of the trigeminal nerve.

Tonsils (tonsillæ palatinæ).—The tonsils are two prominent masses of lymphoid tissue placed one on each lateral wall of the pharynx in the triangular interval between the two palatine arches and immediately above the pharyngeal part of the tongue. The *pharyngeal* or *internal surface* of the tonsil is perforated by a number of orifices which lead into crypts or recesses in its substance. The *deep* or *external surface* is embedded in the pharyngeal wall and is supported by the superior constrictor muscle of the pharynx. It is covered by a layer of fibrous tissue which forms an incomplete capsule for the organ. It is important to note that between the tonsil and the superior constrictor there is some lax connective tissue, so that the organ can be pulled forwards by the volsellum without dragging the wall of the pharynx with it.

The tonsils have a rich *blood-supply*. They derive arterial twigs from the tonsillar and inferior palatine branches of the facial, the descending palatine branch of the internal maxillary, the ascending pharyngeal, and the dorsalis linguæ.

Eustachian Tube (tuba auditiva).—This is the canal which conveys air from the pharynx to the tympanic cavity. It is divided into two portions, according to the parts which enter into the construction of its wall. Thus, in the *outer part* of its course as it nears the tympanum, its wall is bony, and it runs in the interval between the squamous and petrous portions of the temporal bone. The *inner part* is placed on the base of the skull, and is lodged in the gutter or groove between the apex of the petrous part of the temporal bone and the great wing of the sphenoid. This is the subdivision of the tube which comes under the notice of the dissector at the present stage, and he should first note its direction and then study its relations and the construction of its wall.

The direction of the canal can be readily ascertained by passing a probe into it through its pharyngeal orifice. It will be seen to run backwards and outwards with a slight inclination upwards. At the same time it will be noticed to pass between the origin of the levator palati, which lies upon its inner side, and the origin of the tensor palati, which is placed upon its outer side. This relationship is best seen in coronal sections through the frozen head. The dissector should now proceed to remove the mucous membrane from around the pharyngeal orifice of the tube. This will reveal the fact that its wall is strengthened by a triangular plate of cartilage, which is folded upon itself so as to protect the tube on its upper and inner aspects. The cartilage is deficient below and externally, its place being taken by dense fibrous tissue, which connects the margins of the cartilage and completes the wall of the canal. The projecting free margin of the cartilage gives rise to the Eustachian cushion already examined on the lateral wall of the naso-pharynx (p. 373). A muscular slip, which descends from the outer margin of the cartilage in relation to the outer unprotected side of the tube, has been termed the *dilatator tubæ* (Rudinger). It joins the tensor palati. The interior of the tube is lined by mucous membrane continuous with that of the pharynx, and its calibre is very different in different parts of its course. It is narrowest at a point termed the *isthmus*, situated at the junction of the osseous and cartilaginous parts. As the tube is traced from this to the pharynx it gradually increases in calibre, and attains its greatest width at its opening into the nasal pharynx.

CAROTID CANAL.

The carotid canal, which traverses the fore-part of the petrous bone, contains the internal carotid artery and the upward continuation of the cervical sympathetic.

Dissection.—The carotid canal may be opened up by removing its inferior wall with the bone pliers. In doing this, it is not necessary to interfere with the Eustachian tube, which lies in close proximity. It is well to preserve this structure until we undertake the dissection of the otic ganglion.

Internal Carotid Artery.—The internal carotid artery in this part of its course is about three-fourths of an inch long. At first it ascends vertically; then, bending suddenly, it runs horizontally forwards and inwards. It emerges from the canal at the apex of the petrous bone, and enters the cranial cavity by piercing the external layer of the dura mater. From *this point* onwards the internal carotid artery has been already examined (p. 328). Whilst within the carotid canal it lies in front of and below the cochlea and the tympanum. The Gasserian ganglion is placed above it, and separated from it by a thin plate of bone, which is sometimes absent.

Ascending Part of the Cervical Sympathetic.—The dissector has already noted a large branch proceeding from the upper end of the superior cervical ganglion and entering the carotid canal with the internal carotid artery. This almost immediately divides into two parts, which place themselves one on either side of the artery, and supply branches to its coats. The further dissection of these branches is a matter of some difficulty, and can only be satisfactorily effected under specially favourable circumstances. The *external branch* breaks up into the *carotid plexus*; the *internal branch* is continued into the *cavernous plexus*. From these primary offshoots secondary plexuses are prolonged upon the various branches which spring from the internal carotid artery.

The *carotid plexus*, which lies upon the outer aspect of the internal carotid artery, gives off the following branches—(1) one or two filaments to the abducent or sixth nerve as it turns round the internal carotid artery; (2) one or two twigs which join the inner part of the Gasserian ganglion; (3) the large deep petrosal nerve; (4) the small carotico-tympanic nerve.

The *large deep petrosal nerve* runs to the posterior aspect of the body of the sphenoid, and at the entrance to the Vidian canal it joins the *great superficial petrosal nerve* and forms the *Vidian nerve* (p. 329).

The *carotico-tympanic branch* of the carotid plexus joins the tympanic branch of the glosso-pharyngeal as it traverses the tympanum (p. 315).

The carotid plexus also receives the *small deep petrosal nerve* from the tympanic branch of the glosso-pharyngeal.

The *cavernous plexus* has already been sufficiently described on p. 329.

SUPERIOR MAXILLARY NERVE.

As the superior maxillary nerve proceeds forwards from the Gasserian ganglion to reach the face, it traverses the upper part of the spheno-maxillary fossa and the infra-orbital canal. The dissector should therefore proceed to expose the nerve in these localities.

Dissection.—Remove the temporal muscle and the upper head of the external pterygoid muscle, and, placing the saw upon the cut margin of the skull at a point immediately above the external auditory meatus, carry it obliquely downwards and forwards through the squamous part of the temporal bone and the great wing of the sphenoid towards the inner end of the sphenoidal fissure. This saw-cut should enter the sphenoidal fissure immediately to the outer side of the foramen rotundum. A second saw-cut should then be made from the cut margin of the cranial wall, immediately above the anterior margin of the great wing of the sphenoid bone, downwards into the sphenoidal fissure to meet the first saw-cut. The wedge-shaped piece of bone included between these cuts can now be removed. Additional space may be obtained and the spheno-maxillary fossa more fully opened up by removing what remains of the great wing of the sphenoid upon the outer side of the foramen rotundum, but the circumference of this aperture must be carefully preserved. Proceed, in the next place, to open up the infra-orbital canal. In its posterior part its upper wall is usually so thin that it can easily be removed by one of the blades of a pair of forceps, but in front it sinks deeply under the lower part of the rim of the orbital opening, and here the chisel must be employed. The superior maxillary nerve can now be defined and its branches displayed. The infra-orbital artery and vein, which accompany the nerve, will be exposed at the same time.

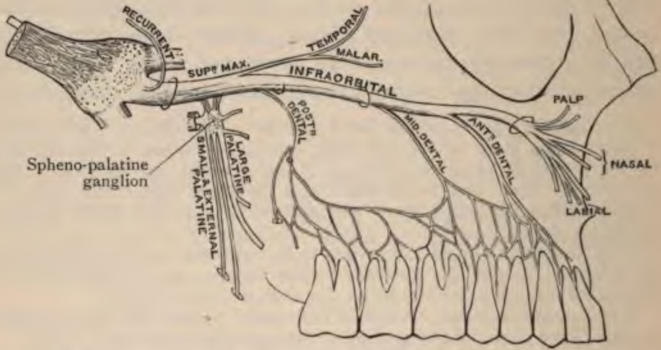

FIG. 141.—Diagram of the Superior Maxillary Nerve.

Superior Maxillary Nerve (nervus maxillaris). — The superior maxillary nerve springs from the Gasserian ganglion within the cranial cavity (p. 326). It is composed entirely of sensory fibres, and proceeds forwards under the dura mater and in relation to the lower part of the cavernous sinus to the foramen rotundum, through which it passes into the spheno-maxillary fossa. The nerve is now carried across the upper part of this fossa and enters the infra-orbital canal, where it receives the name of *infra-orbital*. The infra-orbital canal traverses the floor of the orbit, which also, it should be remembered, forms the roof of the antrum of Highmore. Finally the nerve emerges upon the face through the infra-orbital foramen, and breaks up, under cover of the levator *labii superioris*, into numerous branches, which form a dense plexus with twigs from the facial nerve. Its terminal filaments are distributed to the lower eyelid, the nose, and the upper lip. From its origin within the cranium to its termination on the face, the superior maxillary nerve pursues a nearly straight course, and in each stage it gives off one or more branches. These are:—

1. Within the cranium,	Recurrent (already described, p. 327).	
2. In the spheno-maxillary fossa, . .	Orbital or temporo-malar (already described, p. 347). Spheno-palatine. Posterior superior dental.	
3. In the infra-orbital canal, . . .	Middle superior dental. Anterior superior dental.	
4. In the face, . .	Palpebral, Nasal, Labial,	already described, p. 266.

The *temporo-malar nerve*, which has already been dissected in the orbit, can now be traced back to its origin from the superior maxillary nerve in the spheno-maxillary fossa. The *spheno-palatine branches* are two stout twigs which arise from the under aspect of the superior maxillary nerve, and proceed vertically downwards in the spheno-maxillary fossa to Meckel's ganglion, of which they constitute the *sensory roots.*

Superior Dental Nerves (nervi alveolares superiores).—These are usually three in number, and are distinguished as posterior, middle, and anterior. The middle superior dental nerve is sometimes absent as a separate trunk, in which case it arises in common with the anterior superior dental.

The *posterior superior dental nerve* takes origin in the spheno-maxillary fossa, and almost immediately divides into two branches, which proceed downwards upon the posterior aspect of the body of the superior maxillary bone. They contribute a few fine filaments to the mucous membrane of the cheek and to the gum, and then disappear into the minute posterior dental foramina to supply the three molar teeth and the lining membrane of the antrum of Highmore.

The *middle superior dental nerve* supplies the two bicuspid teeth. It arises from the infra-orbital nerve, a short distance in front of the spheno-maxillary fossa, and can be easily detected (when present) by gently raising the parent trunk from the floor of the canal. It descends in a minute canal which traverses the outer wall of the antrum of Highmore.

The *anterior superior dental nerve*, much the largest of the three dental branches, springs from the infra-orbital as it approaches the fore-part of the canal. It can be brought into view by raising the parent trunk from the floor of the canal, and it will then be seen to enter a special bony tunnel which traverses the upper jaw in front of the antrum of Highmore. The dissector should endeavour to open up this canal with the chisel. After supplying a branch to the mucous membrane of the lower and fore part of the nasal fossa, the anterior superior dental nerve divides into branches for the incisor and the canine teeth.

While traversing the upper jaw, the three superior dental branches communicate with each other, and form two nerve-loops. Numerous twigs proceed from these, and join in a fine plexus. It is from this plexus that the terminal filaments to the teeth and gum take origin.

Infra-orbital Artery (arteria infra-orbitalis).—The infra-orbital artery is a branch of the internal maxillary. It arises in the spheno-maxillary fossa, and accompanies the infra-orbital nerve. In the face its terminal twigs anastomose with branches of the facial, transverse facial, and buccal arteries; in the infra-orbital canal it gives some fine branches to the contents of the orbital cavity, and also the *anterior dental artery* (arteria alveolaris superior anterior), which accompanies the nerve of that name, and supplies the incisor and canine teeth, and the lining membrane of the antrum.

The *infra-orbital vein* joins the pterygoid plexus.

OTIC GANGLION—NASAL FOSSÆ.

Dissection.—The portion of the lower jaw which still remains, together with the tongue and larynx, must now be removed from the upper part of the skull. From the angle of the mouth on each side carry the knife backwards through the buccinator and mucous membrane of the cheek, the pterygo-maxillary ligament, and the lateral wall of the pharynx. The internal pterygoid muscle has already been divided, but it will be necessary to cut the internal carotid artery, with the vessels and nerves which still connect the pharynx with the skull. The larynx and tongue may be laid aside for future dissection.

The fore-part of the skull should next be divided into two lateral parts by sawing it through in the sagittal direction close to one side of the nasal septum. As a general rule the nasal septum is not vertical, but deviates more or less to one or other side of the mesial plane. This deviation is more frequently directed to the right than to the left side. Endeavour to determine the direction which it takes in the skull under observation by passing a probe into the nasal fossæ through the posterior nares. The section through the skull should be made close to the concave side of the septum. Begin in front by introducing a knife into the nostril of that side, and carry it upwards through the cartilaginous part of the nose to the nasal bone. Then place the specimen so that the face rests upon the table, and divide the soft palate from before backwards in the same plane. The section may now be completed by sawing from behind forwards through the hard palate and bony roof of the nasal fossa. The dissector should make every effort to preserve the septum of the nose intact. As a general rule the upper turbinated bone is partially injured. This is not a very serious matter, as the outer aspect of the nasal fossa can be studied upon the opposite side when the septum of the nose has been removed.

If the part has been well preserved, the dissector should be able at this stage to expose the otic ganglion, and perhaps also some of its more important connexions. Turn the specimen so that its inner surface looks upwards, and, carefully detaching the levator palati from its origin, throw it downwards. Then remove the cartilaginous part of the Eustachian tube. In doing this, the dissector must proceed with the greatest caution, because the ganglion lies immediately subjacent. By following the nerve to the internal pterygoid muscle upwards and backwards to its origin the otic ganglion will be discovered.

Otic Ganglion (ganglion oticum).—This is a minute oval body about 4 mm. in length. It is placed immediately below the foramen ovale, between the deep surface of the inferior maxillary nerve and the tensor palati which separates it from the cartilaginous part of the Eustachian tube. The middle meningeal artery lies behind it, and it lies in the most intimate relationship to the origin of the nerve to the internal pterygoid muscle.

The otic ganglion is usually described as receiving motor, sensory, and sympathetic roots. The *motor root* is supplied by the nerve to the internal pterygoid muscle; the *sympathetic root* comes from the plexus around the middle meningeal artery. In addition to these, the *small superficial petrosal nerve* enters the posterior border of the ganglion, and conveys to it *sensory fibres* from the glosso-pharyngeal nerve (p. 314).

The following are the *branches* which proceed from the otic ganglion :—

Branches of distribution.	A twig which passes downwards and forwards to the tensor palati.
	A twig which proceeds upwards and backwards to supply the tensor tympani.
Connecting branches.	One or more fine filaments to one or both of the roots of the auriculo-temporal nerve.
	A minute communicating filament to the chorda tympani.

Nasal Septum (septum nasi).—The nasal septum divides the cavity of the nose into two narrow chambers—the right and left nasal fossæ. It is not placed accurately in the mesial plane, but almost invariably shows a bulging or deviation to one or other side (more frequently to the right side), so as to reduce the width of one fossa, and increase the capacity of the other. Immediately above the orifice of the nostril, or the anterior aperture of the nasal fossa, the septum shows a slight depression, which corresponds to the *vestibule* of the nose, and forms the inner wall of this subdivision of the nasal chamber. The vestibular part of the partition is clothed by skin, continuous with the external integument; from this a number of stiff hairs, termed *vibrissæ*, project. Over the rest of its extent the septum nasi is covered

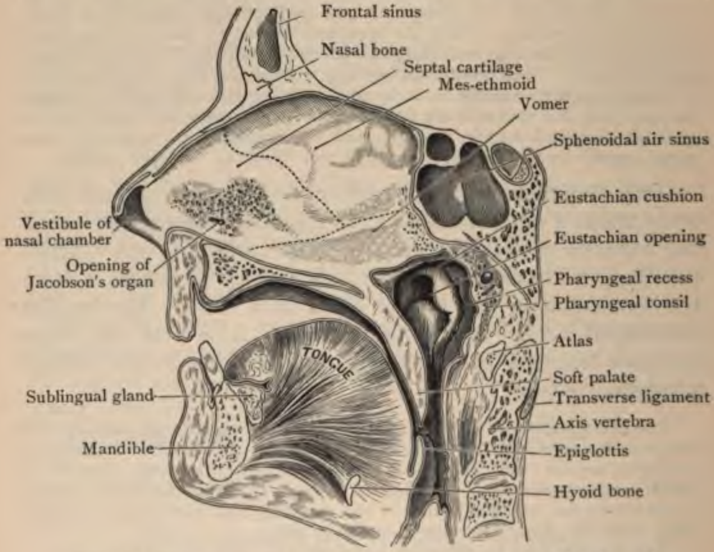
Frontal sinus
Nasal bone
Septal cartilage
Mes-ethmoid
Vomer
Sphenoidal air sinus
Eustachian cushion
Vestibule of nasal chamber
Eustachian opening
Opening of Jacobson's organ
Pharyngeal recess
Pharyngeal tonsil
Atlas
TONGUE
Soft palate
Sublingual gland
Transverse ligament
Axis vertebra
Mandible
Epiglottis
Hyoid bone

FIG. 142.—Antero-posterior section through the Nose, Mouth, and Pharynx, a little to the left of the mesial plane.

with mucous membrane, and presents two districts, viz., a lower or respiratory area, and a much smaller upper or olfactory area, comprising not more than the upper third of the septum in which the branches of the olfactory nerve spread out. The respiratory mucous membrane is very thick and spongy. It is highly vascular, and contains numerous racemose glands. The minute orifices of the gland ducts can be detected by the naked eye. Over the olfactory district of the septum, the mucous membrane is softer and more delicate, and not so thick. In the fresh state it presents a ellowish colour, and the glands are smaller.

In favourable cases a minute orifice may be detected in the mucous membrane on the lower and fore part of the nasal septum immediately behind the vestibular area. It is placed above the anterior end of a well-marked elongated projection which passes obliquely backwards and upwards, and corresponds to the thickened lower margin of the septal cartilage. This aperture varies in diameter from ½ mm. to 1½ mm. (Schwalbe). It leads into a narrow canal, which passes backwards for a short distance, and then ends blindly. It is of interest because it represents in the human subject the rudiment of the *organ of Jacobson*, a tubular structure which is highly developed in some of the lower animals.

Construction of the Nasal Septum.—Strip the mucous membrane from the exposed surface of the septum nasi. By this proceeding the intimate connexion which exists between the mucous membrane and the subjacent periosteum and perichondrium will become apparent, and the parts forming the septum will be rendered visible. The bulk of the partition is composed of the perpendicular plate of the ethmoid and the vomer posteriorly, and of the septal cartilage in front. Small portions of other bones take a minor part in its construction. Thus, above and behind there are the crest and rostrum of the sphenoid; above and in front is the nasal spine of the frontal bone; whilst below there is the crest of bone formed by the apposition of the palatal processes of the palate and superior maxillary bones of opposite sides.

The *septal cartilage* (cartilago septi nasi) fills up the wide angular gap which intervenes between the perpendicular plate of the ethmoid and the vomer, and it projects forwards towards the point of the nose. It is a broad irregularly quadrilateral cartilaginous plate. Its *upper and posterior border* is in apposition with the fore border of the mes-ethmoid; *its lower and posterior border*, much thickened, is received into the groove in the fore border of the vomer and the incisor crest of the maxillary bones. The angle between these two borders is prolonged backwards for a varying distance in the form of a tongue-shaped cartilaginous process, which occupies the interval between the two plates of the vomer. The *upper and anterior border* of the septal cartilage is in contact above with the suture between the two nasal bones; below this it is related to the two lateral cartilages of the nose, whilst still lower down it is seen in the interval between the two cartilages of the nasal aperture. Its connexion with the lateral cartilage of each side is a very intimate one; indeed, below the nasal bones the three cartilages are directly continuous, but lower down they are separated by a fissure which runs upwards for some distance on each side. The *lower and anterior border* is very short; it is free, and extends backwards to the anterior nasal spine. The anterior angle of the septal cartilage is blunt and rounded, and does not reach to the point of the nose, which is thus formed by the cartilages of the aperture (p. 279).

The deviation of the septum nasi from the mesial plane will now (in all probability) be seen to be due to a bulging to one side of the vomer and mes-ethmoid along their line of union. It is not developed until after the seventh year of life.

Dissection.—The septal cartilage and thin bony laminæ must now be removed piecemeal. This must be done very carefully, as it is necessary to preserve intact the mucous membrane which clothes the opposite side of the septum. It is in this that the nerves and blood vessels must be examined.

Vessels and Nerves of the Septum Nasi.—The following is a list of the nerves:—

Nerves of Smell, .	Olfactory.
Nerves of Common Sensation, . .	1. Naso-palatine. 2. Septal branch of the nasal nerve proper. 3. Nasal branches from Meckel's ganglion and from the Vidian nerve.

The *inner group of olfactory nerves* which are distributed in the mucous membrane of the upper part of the nasal septum are barely distinguishable, except in a fresh part; further, they are so soft, that it is hardly possible to isolate them. They enter the nasal fossa through the inner series of apertures in the cribriform plate of the ethmoid, and proceed downwards in grooves on the surface of the perpendicular plate of the same bone.

The *naso-palatine nerve* (nervus naso-palatinus) is a long slender twig which can easily be detected upon the deep surface of the mucous lining of the septum. It springs from Meckel's ganglion, and enters the nasal fossa through the spheno-palatine foramen. In the first part of its course it runs horizontally inwards upon the under surface of the body of the sphenoid. Having gained the nasal septum, it changes its direction and proceeds downwards and forwards in a shallow groove on the surface of the vomer under cover of the mucous lining. Finally it enters the foramen of Scarpa, and where the two foramina of Scarpa open into the common anterior *palatine* canal, the nerves of opposite sides unite in a plexus from which branches are given to the mucous membrane covering the fore-part of the hard palate. The naso-palatine nerve is accompanied by the corresponding artery, and as it lies on the surface of the vomer, it supplies some small twigs to the mucous membrane of the septum nasi.

A few *nasal branches* from Meckel's ganglion, and also from the Vidian nerve, reach the mucous membrane over the upper and back part of the septum. They are very minute, and it is questionable if the dissector will be able to discover any trace of them.

The *septal branch of the nasal nerve proper* will be found descending over the fore-part of the nasal septum. It runs between the mucous membrane and the septal cartilage, and its terminal twigs may be traced as far as the vestibule.

The *arteries* which convey blood to the septum nasi are: (1) the naso-palatine, which accompanies the nerve of the same name; (2) a branch of the anterior ethmoidal accompanying the septal branch of the nasal nerve; (3) some minute twigs to the upper part of the septum from the posterior ethmoidal artery; (4) the septal branch of the superior coronary artery, which is distributed upon the columna nasi.

Dissection.—The mucous membrane of the septum may now be divided by the scissors along the roof of the nasal cavity. Before doing this, disengage from its surface the naso-palatine nerve and the septal branch of the nasal nerve proper, in order that they may be afterwards traced to their origins. When the layer of mucous membrane thus detached from the roof of the nose is thrown inwards the nasal fossa is exposed.

Nasal Fossæ (cavum nasi).—These are two chambers placed one on each side of the septum nasi. They are extremely narrow, but the vertical depth and antero-posterior length of each fossa is very considerable. The width increases somewhat from above downwards; thus, in the upper part, the superior turbinated bone is only separated from the septum by an interval of 2 mm., whilst lower down we find a space of 4 or 5 mm. intervening between the inferior turbinated bone and the septum. Each nasal fossa presents an inner wall formed by the septum, an outer wall, a roof, a floor, and an anterior and a posterior aperture.

The *anterior apertures* of the nasal fossæ or nostrils are two oval orifices which open upon the face and look downwards. The *posterior apertures* or *choanæ* open into the nasopharynx and look directly backwards.

The narrow *roof* of the nasal fossa consists of an *intermediate* horizontal portion formed by the cribriform plate of the ethmoid bone, and of an anterior and a posterior sloping part. The *anterior part* inclines downwards and forwards, and is formed by the narrow grooved nasal surface of the nasal spine of the frontal bone, the nasal bone, and the angle between the lateral cartilage and the septal cartilage. The *posterior part* of the roof, which slopes downwards and backwards, is composed of the fore and under surfaces of the body of the sphenoid, as well as the spread-out ala of the vomer and the sphenoidal process of the palate bone, both of which are applied to the under surface of the sphenoidal body.

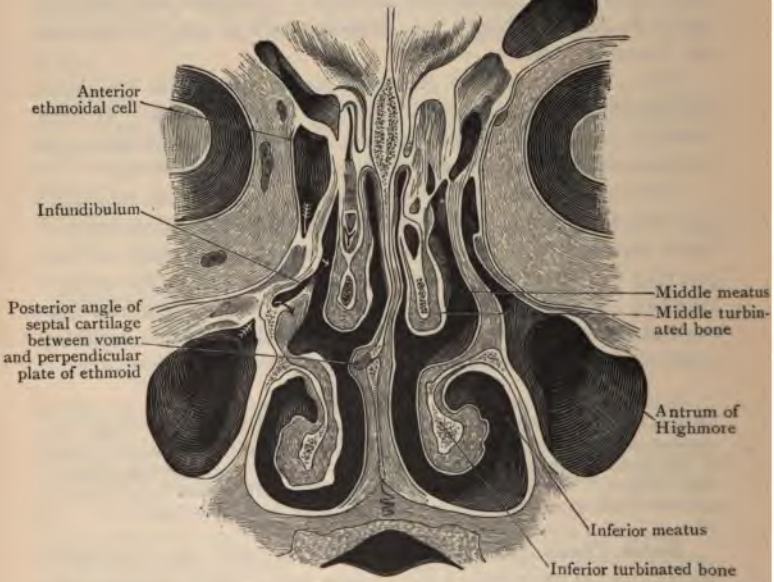
Anterior ethmoidal cell
Infundibulum
Posterior angle of septal cartilage between vomer and perpendicular plate of ethmoid
Middle meatus
Middle turbinated bone
Antrum of Highmore
Inferior meatus
Inferior turbinated bone

FIG. 143.—Coronal section through the Nasal Cavities opposite the Crista Galli of the Ethmoid Bone; viewed from behind.

The *upper arrow* passes through the opening of the anterior ethmoidal cell into the hiatus semilunaris. The *lower arrow* passes from the antrum of Highmore into the hiatus semilunaris.

The *floor* of the nasal fossa is of considerable width. It is formed by the palatal processes of the superior maxillary and palate bones, and is concave from side to side. Further, it presents a gentle slope from before backwards, being slightly higher in front than behind. On the anterior part of the floor, and close to the septum nasi, the dissector may observe a minute funnel-shaped depression of the mucous membrane into the incisor foramen. This is of interest from a developmental point of view; it is a vestige of the extensive communication which existed in the embryo between the cavities of the nose and the mouth.

Outer Wall of the Nasal Fossa.—The outer wall of the nasal cavity is rendered uneven and complicated by the projection of the three turbinated bones.

The part which the different bones take in the formation of the outer wall of the cavity of the nose must in the first place be studied in a sagittal section through the macerated skull, and the dissector should constantly refer to such a preparation during the dissection. In front, the outer wall of the nasal cavity is formed by the lateral cartilage, the cartilage of the aperture, the nasal bone, and the ascending process of the superior maxillary bone. Behind these, the lachrymal, the ethmoid, and the inferior turbinated bones, with a small portion of the body of the superior maxillary bone, enter into its construction; whilst still farther back are the vertical plate of the palate bone and the internal pterygoid plate of the sphenoid. Placed in relation to the outer aspect of this wall are the ethmoidal air-cells, which intervene between the upper part of the nasal cavity and the orbit, whilst, at a lower level, the great air sinus of the superior maxillary bone, termed the antrum of Highmore, is situated immediately to the outer side of the nasal fossa (Fig. 143).

Turning now to the recent specimen, the dissector will observe that the outer wall may very readily be subdivided into three areas or districts. These are—(1) the vestibule, (2) the atrium meatus medii, (3) the region of the turbinated bones and intervening meatuses.

Vestibulum Nasi.—The *vestibular part* (Fig. 144, 6, 6′) of the outer wall is a depression of a somewhat oval form placed immediately above the aperture of the nostril. It is partially divided into an upper and lower portion by a short ridge which projects forwards from its posterior boundary, and it is clothed throughout by integument continuous with the skin. From this a number of stout, stiff hairs, termed *vibrissæ*, project (Fig. 144, 5). The vibrissæ which spring from the anterior part of the region incline backwards, whilst those which are implanted into the posterior part are directed forwards; in this manner a sieve-like arrangement is provided at the anterior aperture of the nose. The vestibular part of the outer wall is placed opposite the corresponding area on the septum nasi, and the two together constitute an ampullated entrance to the nasal fossa. The capacity and shape of this section of the cavity is influenced to a certain extent by the contraction of the nasal muscles.

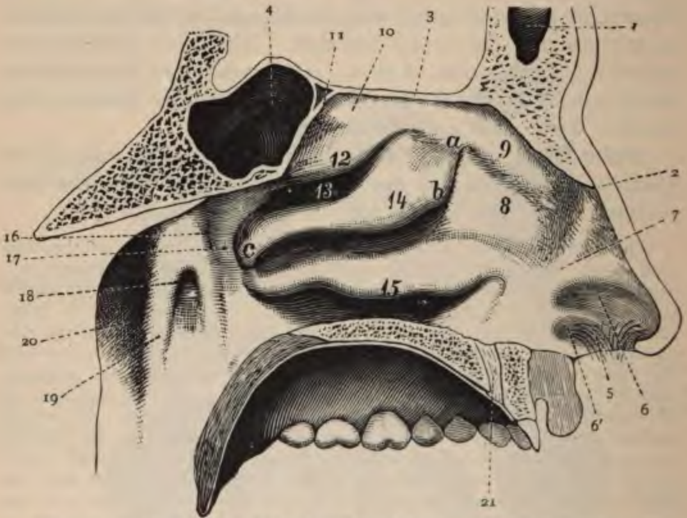

FIG. 144.—Outer Wall of the Left Nasal Fossa. (From Schwalbe.)

1. Frontal air sinus.
2. Free border of the nasal bone.
3. Cribriform plate of ethmoid.
4. Sphenoidal air sinus.
5. Vibrissæ.
6′, 6. Two parts of the vestibular area.
7. Elevation intervening between the vestibular district and the atrium.
8. Atrium meatus medii.
9. Agger nasi, or rudiment of an anterior turbinal.
10. Upper part of the superior turbinated bone (concha suprema)
11. Recessus spheno-ethmoidalis.
12. Superior turbinated bone.
13. Superior meatus.
14. Middle turbinated bone.
15. Inferior turbinated bone.
16. Plica naso-pharyngea.
17. District intermediate between nose and pharynx, and termed the region of the ductus naso-pharyngeus.
18. Orifice of Eustachian tube.
19. Prominent posterior lip of this orifice.
20. Wall of pharynx.
21. Anterior palatine canal.
a, *b*, *c*. Free border of the middle turbinated bone.

Atrium Meatus Medii.—This part of the outer wall of the nasal fossa (Fig. 144) is placed above, and slightly behind the vestibular district, and it receives its name from the fact that it leads directly backwards into the middle meatus of the nose. It is slightly hollowed out and concave, and on its upper part, near the nasal bone, a feeble elevation termed the *agger nasi* may be noticed; this begins close to the forepart of the attached margin of the middle turbinated bone, and proceeds obliquely downwards and forwards. It has been termed by Schwalbe the "rudiment of the anterior turbinal," and he considers that it is the representative of the naso-turbinal which is present in some mammals. A slight depression above the agger nasi leads backwards to the olfactory district of the outer wall of the nasal fossa, and receives the name of *sulcus olfactorius.*

Turbinated Bones.—Behind the vestibule and the atrium are the turbinated bones with the intervening meatuses. The *superior turbinated bone* (concha superior) (Fig. 144), which projects from the lateral mass of the ethmoid bone, is very short, and is placed on the upper and back part of the outer wall of the fossa. Its free border begins a short distance below the centre of the cribriform plate, and proceeds obliquely downwards and backwards to a point immediately below the body of the sphenoid, where it ends. The *middle turbinated bone* (concha media) (Fig. 144) is also a part of the ethmoid. Its free border begins a short distance below the fore-part of the cribriform plate, and at first takes a vertical course downwards; then, bending suddenly, it proceeds backwards, and ends midway between the body of the sphenoid and the posterior border of the hard palate. The *inferior turbinated bone* (concha inferior) (Fig. 144) is an independent bone, and stretches backwards upon the outer wall of the nasal fossa, midway between the middle turbinated bone and the floor of the nose. Its lower free margin is somewhat convex from before backwards.

Meatuses of the Nose (meatus nasi).—The *superior meatus* (Fig. 144) is a short narrow fissure between the superior and middle turbinated bones. The posterior ethmoidal cells open into its upper and fore part by one, or, in some cases, by several apertures.

To bring these orifices into view, the superior spongy bone should be turned aside by introducing the blade of a pair of forceps under its entire length, and forcing it upwards. Care should be taken not to injure the mucous membrane more than is absolutely necessary.

The *middle meatus* is a much more roomy passage which lies between the middle and inferior turbinated bones, and is continued directly forwards into the atrium.

The middle spongy bone should be forcibly tilted upwards and backwards.

The upper and fore part of the middle meatus leads into a funnel-shaped passage which passes upwards into the corresponding frontal sinus. This passage is called the *infundibulum*, and constitutes the channel of communication between the frontal sinus and the nasal chamber.

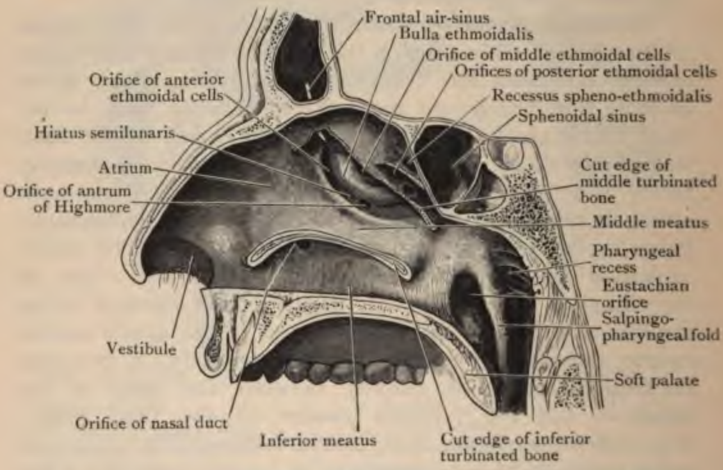
Frontal air-sinus
Bulla ethmoidalis
Orifice of middle ethmoidal cells
Orifices of posterior ethmoidal cells
Orifice of anterior ethmoidal cells
Recessus spheno-ethmoidalis
Sphenoidal sinus
Hiatus semilunaris
Atrium
Cut edge of middle turbinated bone
Orifice of antrum of Highmore
Middle meatus
Pharyngeal recess
Eustachian orifice
Salpingo-pharyngeal fold
Vestibule
Soft palate
Orifice of nasal duct
Inferior meatus
Cut edge of inferior turbinated bone

FIG. 145.—Outer wall of Nasal Chamber and Naso-pharynx. The three turbinated bones have been removed.

Upon the lateral wall of the middle meatus a deep curved groove or gutter, which takes origin at the infundibulum and runs from above downwards and backwards, will be observed. In this groove, which is termed the *hiatus semilunaris* (Fig. 145), are the openings of the anterior ethmoidal cells, and the antrum of Highmore. The upper boundary of the hiatus semilunaris is prominent and bulging. It is termed the *bulla ethmoidalis*. At a higher level than the bulla the aperture of the middle ethmoidal cells will usually be seen (Fig. 145). The slit-like opening of the antrum of Highmore will be noticed in the hinder part of the hiatus semilunaris.

The dissector should now proceed to open up the antrum of Highmore by removing its outer wall. This may be done by sawing upwards through the root of the zygomatic process of the superior maxillary bone.

The orifice by means of which this great air sinus communicates with the middle meatus will be noticed to be placed on the inner wall of the cavity much nearer the roof than the floor—a position highly unfavourable for the escape of fluids which may collect within it. Sometimes, however, a second orifice, circular in outline, will be found. This is situated lower down, and opens into the middle meatus immediately above the middle point of the attached margin of the inferior turbinated bone.

The *inferior meatus* is the horizontal passage which extends backwards between the inferior turbinated bone and the floor of the nasal fossa. It is placed behind the vestibule, and the free border of the projection, which corresponds to the inferior turbinated bone, turns downwards in front so as to limit it anteriorly (Fig. 144). This condition, together with the backward slope of the floor, renders the inferior meatus more accessible to the current of expired air than to the current of inspired air. In the fore-part of this meatus will be found the opening of the nasal duct—the canal which conveys the tears to the nasal fossa (Fig. 145).

To bring the aperture of the nasal duct into view, remove a small portion of the anterior part of the inferior turbinated bone with the scissors.

The orifice of the nasal duct varies in form, according to the manner in which the mucous membrane is arranged around it. Sometimes it is wide, patent, and circular; at other times the mucous membrane is prolonged inwards beyond the bony opening, so as to reduce the size of the aperture and even give it a slit-like character. In some cases indeed the orifice may be so minute that it is a difficult matter to find it. Its continuity with the lachrymal sac should in all cases be established by passing a probe from above downwards through the nasal duct.

A *fourth* meatus is generally present on the outer wall of the nose. It is not at all uncommon to find the superior turbinated bone partially subdivided into an upper and lower part by a short groove, which proceeds forwards from the anterior aspect of the body of the sphenoid. This additional meatus is termed the *recessus spheno-ethmoidalis* (Meyer), and into its back-part opens the aperture of the sphenoidal air sinus (Fig. 145). This orifice may be circular or slit-like, according to the manner in which the mucous membrane is disposed around it.[1] The upper portion of the superior turbinated bone which is placed above this additional meatus is called the *concha suprema* (Fig. 144).

Mucous Membrane of the Outer Wall of the Nose.—The vestibule, as we have noted, is lined by integument. The remainder of the outer wall, as well as the roof and floor of the nasal fossa, is lined by mucous membrane, which is continuous through the nasal duct with the ocular conjunctiva, through the various apertures with the delicate lining membrane of the air-cells which open into the nose, and through the posterior nares with the pharyngeal mucous membrane. On the outer wall, as on the septum, the mucous membrane is mapped out into an upper olfactory and a lower respiratory portion. This subdivision cannot be appreciated by the naked eye, as the one district passes without any sharp line of demarcation into the other. The *olfactory region* (regio olfactoria) comprises merely the upper turbinated bone; the *respiratory region* (regio respiratoria) includes the middle and inferior turbinated bones, the middle meatus, the lower meatus, and the atrium. In the lower part of the outer wall the mucous membrane is thick and spongy. This is particularly noticeable over the lower borders and posterior extremities of the middle and inferior turbinated bones, where the membrane presents an irregular surface and forms soft bulging cushions. This condition is largely due to the presence of a rich venous plexus, the vessels of which run for the most part in an antero-posterior direction. In the case of the lower spongy bone, the veins are so numerous that the mucous membrane assumes the character of cavernous tissue, and is sometimes spoken of as the "erectile body." When turgid with blood, it swells out so as to obliterate the interval between the turbinal bone and the septum. The mucous membrane of the floor, meatuses, and the atrium, is smoother than and not so thick as that over the turbinated bones. Everywhere numerous racemose glands are embedded in its midst, and the minute punctiform orifices of the ducts are visible to the naked eye. In the olfactory region the lining membrane of the nose in the fresh state is of a yellowish colour, and is softer and more delicate than in the respiratory part.

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[1] When the recessus spheno-ethmoidalis is absent, the sphenoidal air sinus opens into the interval between the roof of the nasal fossa and the superior turbinated bone.

The great vascularity of the mucous membrane of the nose is doubtless for the purpose of moistening and raising the temperature of the inspired air.

Nerves and Vessels on the Outer Wall of the Nasal Fossa :—

Nerves of Smell, .	Olfactory nerves.
Nerves of Common Sensation, . .	1. External branch of nasal proper. 2. Nasal branch of anterior superior dental. 3. Superior nasal branches from Meckel's ganglion and from the Vidian nerve. 4. Two inferior nasal branches from the great posterior palatine nerve.

The *olfactory nerves* are from twelve to twenty in number. They are fine filaments which spring from the under surface and the extremity of the olfactory bulb, and, passing through the apertures in the cribriform plate of the ethmoid into the nose, they separate into an outer and an inner group. To each nerve an investment from the cerebral membranes is given. The *inner* or *septal nerves* have been already described (p. 390). The *outer nerves* descend between the mucous membrane and the periosteum on the outer wall of the nose. At first lodged in shallow grooves or minute bony canals, they soon divide into bunches of branches which spread out over the upper turbinated bone and the region immediately below. The dissection of these nerves is exceedingly difficult even in the fresh subject, but in a well-preserved part they can generally be partially displayed.

The *superior nasal branches* which come from the spheno-palatine ganglion and from the Vidian nerve are very minute filaments, but the dissector should not be deterred on this account from endeavouring to trace them to their distribution upon the outer wall. They enter the nose through the spheno-palatine foramen, which is situated at the back part of the superior meatus.

The best plan to adopt for their display is to trace the naso-palatine nerve, which has already been exposed on the nasal septum, outwards across the roof of the nose. This will lead to the foramen, and by carefully dissecting the mucous membrane in its neighbourhood the superior nasal nerves may be detected entering the nasal fossa.

They are distributed to the mucous membrane over the upper and middle turbinated bones; and some filaments are prolonged to the septum.

The *inferior nasal nerves* are two in number, and they both arise from the great posterior palatine nerve.

Carefully raise the mucous membrane from the posterior part of the outer wall of the nasal fossa. Make a vertical incision, through the membrane over the internal pterygoid process, and turn it cautiously over from behind forwards.

The *upper* of the two inferior nasal nerves will be found emerging through a small aperture in the vertical plate of the palate bone, at a point between the posterior extremities of the middle and inferior turbinated bones. It divides into an ascending and descending branch. The former runs forwards on the middle spongy bone; the latter extends forwards upon the inferior spongy bone. The *lower* of the two inferior nasal nerves appears through a foramen in the vertical plate of the palate bone immediately behind the posterior end of the inferior turbinated bone, upon the outer surface of which it proceeds in a forward direction.

The *nasal nerve proper* should be exposed as it descends in the groove upon the deep surface of the nasal bone (p. 338). It gives, as we have noted, a branch inwards to the septum; an external twig may also be traced to the mucous membrane over the fore-part of the outer wall and to the fore-parts of the middle and inferior turbinated bones.

The main *artery* of supply to the nasal mucous membrane is the *spheno-palatine*, a branch of the internal maxillary. It gains entrance to the nasal fossa through the spheno-palatine foramen in company with the superior nasal and naso-palatine nerves. One branch of this vessel—the *naso-palatine*—accompanies the latter nerve, whilst others are distributed upon the outer wall of the cavity. Several twigs are also given by the *descending* or *posterior palatine branch* of the internal maxillary and the *two ethmoidal arteries*, but these are small and will only be seen in cases where the injection of the subject has been unusually successful.

SPHENO-PALATINE GANGLION AND INTERNAL MAXILLARY ARTERY.

The spheno-palatine ganglion or the ganglion of Meckel is situated in the spheno-maxillary fossa on the outer side of the spheno-palatine foramen, and can best be exposed at this stage by dissecting from the inner or nasal side.

Dissection.—The mucous membrane has already been removed from the posterior part of the outer wall of the nasal fossa, and the inferior nasal branches of the great palatine nerve have been found piercing the vertical plate of the palate bone. The dissector cannot fail to notice the course taken by the trunk from which these filaments arise. The lamina of bone which forms the inner wall of the posterior palatine canal is so thin that the nerve can be distinctly seen through it. By carefully opening up this canal with a chisel, and following the great palatine nerve upwards, the dissector will be led to the ganglion in the spheno-maxillary fossa. The naso-palatine nerve should at the same time be traced to its origin. The ganglion is so hemmed in by the bony walls of the fossa that it is very difficult to display it thoroughly; but by removing the orbital process of the palate bone, and a portion of the body of the sphenoid, with the bone forceps, it may be more or less satisfactorily exposed. In the same restricted space will be found the terminal portion of the internal maxillary artery, from which numerous branches are given off.

Spheno-palatine Ganglion (ganglion sphenopalatinum).—This is a small triangular flattened body, which is lodged in the spheno-maxillary fossa. It is embedded in soft fat, and surrounded by the terminal branches of the internal maxillary artery. The two stout spheno-palatine branches which descend from the superior maxillary nerve join it from above, but only a certain proportion of their fibres are involved in the ganglion; the remainder are continued directly into the nasal and palatine nerves which proceed from the ganglion. The spheno-palatine nerves may be regarded as constituting the *sensory roots* of the ganglion.

From the spheno-palatine ganglion branches are given off which radiate in four directions—viz., inwards to the nose; downwards to the palate; backwards to establish connexions with the facial nerve and carotid plexus, as well as to supply the mucous membrane of the pharynx; and upwards to the orbit.

Internal branches, .	Superior nasal. Naso-palatine.
Descending branches,	Large posterior palatine. Small posterior palatine. Accessory posterior palatine.

Posterior branches, .	Vidian. Pharyngeal.
Ascending branches, .	Orbital.

From the internal maxillary artery twigs are given off which accompany these nerves.

The *superior nasal* and the *naso-palatine nerves* have been already described (pp. 399 and 390). They arise from the inner aspect of the ganglion, but in some cases the naso-palatine may be seen to take origin from the commencement of a common palatine trunk, or even from one of the spheno-palatine branches of the superior maxillary nerve.

The *posterior palatine nerves* (nervi palatini) are three in number, and are distinguished as *large*, *small*, and *accessory*. As a rule these spring by a common trunk from the lower aspect of the ganglion. This descends in the posterior palatine canal, which has already been opened up, but to expose the nerves a dense fibrous investment must be removed. The nerve-trunk will then be observed to break up into its three constituents.

Dissection.—Trace, in the first instance, the two smaller nerves—viz., the small and the accessory posterior palatine branches. These leave the main canal, and enter smaller tunnels, which conduct them through the tuberosity of the palate bone. Before opening these up it is well to secure the nerves as they emerge from the lower openings of the canals. This can very readily be done by dissecting behind the hamular process, and gently separating the soft parts from the under aspect of the tuberosity of the palate bone. As the dissection is being made from the inside, the *small posterior palatine nerve* will be first encountered, and it will be seen to pass backwards into the soft palate, under cover of the tendinous expansion of the tensor palati.[1] This must be divided, in order that the posterior palatine nerve may be followed to its distribution. The *accessory posterior palatine nerve* will be found issuing from its canal a short distance to the outer side of the preceding nerve. It is distributed to the soft palate in the neighbourhood of the tonsil. It is smaller than the posterior palatine nerve, and is sometimes absent. The *large posterior palatine nerve* should now be followed onwards to the hard palate. To do this the lower part of the posterior palatine canal must be opened up by removing a small portion of the posterior and outer part of the horizontal plate of the palate bone.

The *large posterior palatine nerve*, as it emerges from the posterior palatine foramen, turns forwards, and divides into branches, which lie in grooves on the under aspect of the hard palate. It supplies the gum, the mucous membrane, and glands of the vault of the mouth, and in the neighbourhood of the anterior palatine foramen it effects a communication with the naso-palatine nerve. During its passage through the posterior palatine canal this nerve has already been observed to supply *two inferior nasal branches* (p. 400).

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[1] The present is a good opportunity to observe the corrugated or wrinkled appearance of the tendon of the tensor palati, as it passes under the hamular process.

In tracing the *large* palatine nerve forwards in the palate, the dissector should note the numerous glands which are placed under the mucous membrane of the vault of the mouth, and the manner in which these indent the bone.[1]

Dissection.—Considerable difficulty will be experienced in exposing the *pharyngeal* and *Vidian nerves.* They proceed backwards from the posterior part of the ganglion in canals which are very inaccessible.

To open up the pterygo-palatine canal the sphenoidal process of the palate bone must be cautiously removed by the bone forceps, and then the dissector should proceed to open up the Vidian canal, which traverses the root of the pterygoid process. As the bone is very hard and brittle at this point, the dissection must be effected very carefully.

The *pharyngeal nerve* occupies the pterygo-palatine canal, and is distributed to the mucous membrane of the upper part of the pharynx.

The *Vidian nerve* (nervus canalis pterygoidei) has previously been seen to be formed by a junction between the *great superficial petrosal branch* of the facial and the *great deep petrosal branch* of the carotid plexus (p. 329). It traverses the Vidian canal, and joins the posterior aspect of the ganglion, of which it may be considered to represent both the *motor* and *sympathetic root.* In the canal it is invested by a strong fibrous envelope, and when this is removed it may sometimes be noticed to break up into a fine plexus which surrounds the accompanying artery. It has already been observed to give some fine filaments to the mucous membrane of the nose.

The *orbital branches* (rami orbitales) of the ganglion are exceedingly minute, and ascend through the spheno-maxillary fissure to supply the periosteum of the orbit.

Termination of Internal Maxillary Artery.—The internal maxillary artery breaks up into its terminal branches in the spheno-maxillary fossa. These have already been traced. They are—

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[1] An equally good method of tracing the large posterior palatine nerve forwards is to remove the palatal processes of the palate and superior maxillary bones with the bone pliers, and then to display the nerve and artery on the upper surface of the mucous membrane and glands.

1. The posterior dental (arteria alveolaris superior posterior) (p. 286).
2. The infra-orbital (p. 386).
3. The descending palatine.
4. The Vidian.
5. The pterygo-palatine.
6. The spheno-palatine.

The *descending palatine* (arteria palatina descendens) accompanies the *large posterior palatine nerve.* During its passage through the posterior palatine canal, it gives off twigs which accompany the small and accessory posterior palatine nerves and the two inferior nasal branches of the great palatine nerve. On the hard palate it dispenses branches to the gum, mucous membrane, and glands, and sends a small branch upwards through the incisor foramen to anastomose with the naso-palatine artery.

The *Vidian artery* (arteria canalis pterygoidei) runs backwards in the Vidian canal to supply the mucous membrane of the upper part of the pharynx and of the Eustachian tube.

The *pterygo-palatine artery* traverses the canal of the same name, and has a corresponding distribution.

The *spheno-palatine* (arteria sphenopalatina) enters the nasal fossa through the spheno-palatine foramen, and has already been followed to its distribution (p. 400).

INTRAPETROUS PART OF THE FACIAL NERVE AND THE AUDITORY NERVE.

The facial and auditory nerves, together with the pars intermedia, have already been traced into the internal auditory meatus (p. 126). The dissector should now open up this meatus and follow the facial nerve in its course through the petrous portion of the temporal bone. The canal which it occupies is termed the *aqueduct of Fallopius.* This begins at the bottom of the internal auditory meatus, and opens on the exterior of the skull at the stylo-mastoid foramen. Between these points it pursues a complicated course, and this, combined with the density of the bone, renders the dissection very difficult.

Dissection.—Perhaps the easiest method of opening up the aqueduct is, in the first instance, to decalcify the bone in a weak solution of acid; but, at the same time, it should be understood that, with a little care, there is nothing to hinder the dissector carrying out the dissection on the hard bone by means of the saw and the chisel.

Separate the temporal bone from the other cranial bones which still adhere to it, and, having fixed it in its natural position (in a vice if possible), remove the squamous portion by a horizontal saw-cut at the level of the superior border of the petrous bone. A second horizontal saw-cut should then be made through the pars petrosa immediately above the roof of the internal auditory meatus. If this is successfully carried out, the vestibule, the upper part of the tympanum, and the mastoidal cells are opened. Upon the upper part of the inner wall of the tympanum above the stapes and the foramen ovale, a prominent ridge will be noticed running from before backwards. This is the aqueduct of Fallopius. Extend the opening into the tympanum by removing the remainder of its roof, and then, with the chisel, open up the aqueduct as seen in this part of its course. The facial nerve is now exposed in what may be said to be its intermediate or tympanic part. To display its first stage within the bone, open up the internal auditory meatus by removing what remains of its roof, and follow the facial nerve forwards and outwards by means of the chisel. This will lead to the geniculate ganglion—the swelling which marks the point at which the nerve bends backwards to enter the tympanic part of the aqueduct. Be careful at this point to secure the branches which proceed from the gangliform enlargement. The terminal part of the aqueduct of Fallopius is vertical, and its course can be indicated by pushing a fine pin upwards through the stylo-mastoid foramen. To open it, the mastoid process must be removed by a coronal (vertical-transverse) saw-cut on a plane immediately behind the stylo-mastoid foramen. When this has penetrated the bone as far as that foramen, a second saw-cut should be made in the sagittal (antero-posterior and vertical) direction, to meet the extremity of the first. The piece of bone thus marked out may now be detached, and a little work with the chisel will display the facial nerve in this part of the canal. Three branches are given off from it here—viz., the nerve to the stapedius, the chorda tympani, and the communicating branch or branches to the auricular nerve from the vagus. The last of these is probably destroyed by the dissection, but the other two can be brought into view by gently raising the nerve from the anterior wall of the canal. By using the chisel in front, and to the inner side of the geniculate ganglion, the cochlea will be exposed.

Intrapetrous Portion of the Facial Nerve.—As the facial nerve traverses the petrous bone, it may be divided into four stages, which differ from each other in the relations they present and in the direction which they take. They are:—

1. A part within the internal auditory meatus.
2. A very short part which extends from the bottom of the internal auditory meatus to the geniculate ganglion.
3. A part which occupies that portion of the aqueduct of Fallopius which runs along the inner wall of the tympanum.
4. A part which extends vertically downwards to the stylo-mastoid foramen.

First stage.—In the internal auditory meatus, the facial nerve runs almost directly outwards in company with the auditory nerve and the pars intermedia. In this stage of its course it lies in relation to the upper and fore part of the auditory nerve, and is joined by the pars intermedia. At the bottom of the auditory meatus it enters the aqueduct of Fallopius.

Second stage.—The second part of the facial nerve is very short. It runs outwards with a slight inclination forwards between the vestibule and cochlea, and very soon ends in the swelling termed the *geniculate ganglion.*

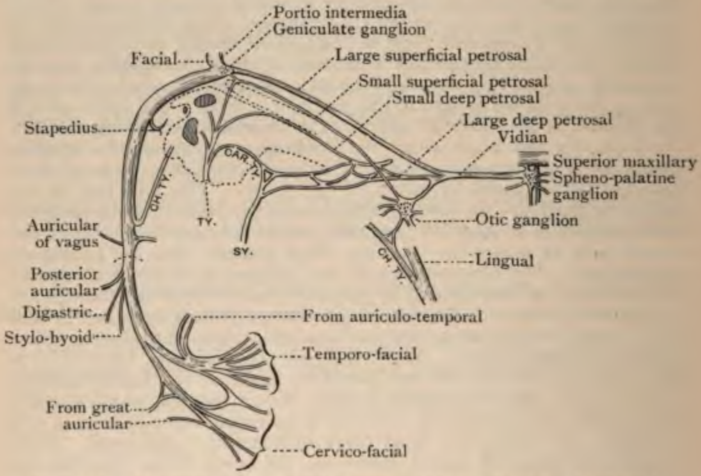
Portio intermedia
Geniculate ganglion
Facial
Large superficial petrosal
Small superficial petrosal
Small deep petrosal
Large deep petrosal
Vidian
Stapedius
CAR. TY.
CH. TY.
Superior maxillary
Spheno-palatine ganglion
TY.
SY.
Otic ganglion
Auricular of vagus
CH. TY.
Lingual
Posterior auricular
Digastric
Stylo-hyoid
From auriculo-temporal
Temporo-facial
From great auricular
Cervico-facial

FIG. 146.—Diagram of the Facial Nerve. (Thane, *Quain's Anatomy.*)

Ch. Ty. Chorda tympani; its middle part is removed.
Ty. Tympanic branch of the glosso-pharyngeal.
Sy. Sympathetic on the internal carotid artery.
Car. Ty. Carotico-tympanic nerve.

Third stage.—At the geniculate ganglion, the facial nerve bends suddenly and then proceeds backwards and slightly downwards in that portion of the aqueduct which runs along the upper part of the inner wall of the tympanum, immediately above the fenestra ovalis.

The first three portions of the facial nerve are nearly horizontal, and pursue a somewhat V-shaped course. The apex of the V is directed forwards, and corresponds to the geniculate ganglion.

The *fourth stage* is vertical, and arches downwards behind the pyramid to gain the stylo-mastoid foramen.

The *branches* which spring from the facial nerve during its passage through the temporal bone are:—

1. The great superficial petrosal nerve,
2. Communicating twig to tympanic branch of the glosso-pharyngeal,
3. External superficial petrosal nerve,

   from geniculate ganglion.

4. Nerve to stapedius.
5. Chorda tympani.
6. Communicating twigs to the auricular branch of vagus.

The *great superficial petrosal nerve* has already been examined (p. 329). Its origin from the geniculate ganglion of the facial can now be established by breaking through the roof of the hiatus Fallopii with the chisel.

The *communicating branch* to the tympanic nerve arises from the geniculate ganglion, and its union with the tympanic forms the small superficial petrosal nerve (p. 314).

The *external superficial petrosal nerve* is not always present. It joins the sympathetic plexus which accompanies the middle meningeal artery.

The *nerve to the stapedius muscle* arises from the facial as it arches downwards behind the pyramid. It enters the base of the pyramid and thus reaches the stapedius muscle.

The *communicating twigs to the auricular branch* of the vagus arise a short distance above the stylo-mastoid foramen.

Chorda Tympani.—The chorda tympani, which represents the pars intermedia set free from the facial nerve, is the largest branch which is given off by the facial during its passage through the aqueduct of Fallopius. It takes origin a short distance above the stylo-mastoid foramen, and arching upwards and forwards in a narrow canal in the petrous portion of the temporal bone (iter chordæ posterius) it appears in the tympanum below the base of the pyramid, and close to the posterior margin of membrana tympani. The bony tunnel which it occupies can easily be opened up in a decalcified bone, but is somewhat difficult to expose in the hard bone. The chorda tympani now runs forwards upon the upper part of the membrana tympani under cover of the mucous layer. It crosses the handle of the malleus near its root. To display it in this part of its course, the incus bone should be removed. Finally, reaching the anterior end of the tympanic cavity it crosses the processus gracilis of the malleus, and near the inner end of the Glaserian fissure it enters a canal (canal of Huguier) which conducts it to the exterior of the skull. With a little care the canal of Huguier can be opened up by the chisel and bone pliers. From this point to its junction with the lingual nerve the chorda tympani has already been traced (p. 294).

Auditory Nerve.—In the internal auditory meatus the auditory nerve lies at a lower level than the facial, and at the bottom of the passage it splits into two parts, termed the *cochlear* and *vestibular divisions.* These trunks again subdivide and supply the different parts of the labyrinth of the ear through the foramina of the lamina cribrosa.

THE LARYNX.

The lateral portions of the lower jaw which are still attached by mucous membrane to the sides of the tongue should be removed, and the dissection of the larynx commenced.

General Construction and Position.—The larynx constitutes the upper expanded portion of the air-passage, specially modified for the production of the voice. Its walls are composed of cartilages, muscles, ligaments, and an internal lining of mucous membrane. Before proceeding with the dissection the student should study the form and connexions of the nine laryngeal cartilages in a permanent specimen (*v.* p. 425).

The larynx is placed in the upper and fore part of the neck, where it forms a marked projection. It lies below the hyoid bone and tongue, whilst inferiorly it is directly continuous with the trachea. In *front* it is covered by the integument and deep cervical fascia, and on either side of the mesial plane by two thin strata of muscles, viz., the sterno-hyoid, the omo-hyoid, the sterno-thyroid, and the thyro-hyoid. As a general rule a narrow process of the thyroid body, termed the *central lobe*, is also continued upwards on its anterior surface. On *each side* the lateral lobe of the thyroid body is prolonged upwards upon it, and it is related to the great vessels of the neck. *Posteriorly* it is in relation to the pharynx ;

by this it is separated from the prevertebral muscles. If we consider the tip of the epiglottis to represent its upper limit, the larynx in the adult may be regarded as being placed in front of that portion of the vertebral column which extends from the lower border of the third to the lower border of the sixth cervical vertebra; but its position alters somewhat with the movements of the head and also during deglutition.

Interior of the Larynx.—The cavity of the larynx is smaller than might be expected from an inspection of its exterior. On looking into its interior from above it will be seen to be subdivided into three portions by two elevated folds of mucous membrane which extend from before backwards, and project inwards from each side of the cavity. The upper pair of folds are termed the *false vocal cords*; the lower pair receive the name of the *true vocal cords.* The latter are the chief agents in the production of the voice, and the larynx is so constructed that changes in their relative position and in their degree of tension are brought about by the action of the muscles and the recoil of the elastic ligaments.

The **Upper Subdivision** of the laryngeal cavity (Fig. 147) extends from the superior aperture of the larynx down to the upper or false vocal cords. It is called the *vestibule* (vestibulum laryngis). In its lower part it exhibits a marked lateral compression. Its width therefore diminishes from above downwards, whilst owing to the obliquity of the upper opening of the larynx its depth becomes rapidly reduced from before backwards. *In front* it is bounded by the posterior surface of the epiglottis and the thyro-epiglottidean ligament, both covered by mucous membrane. This wall descends obliquely from above downwards and forwards, and becomes narrower as it approaches the anterior ends of the false vocal cords. The *lateral wall* of the vestibule is formed by the inner surface of the aryteno-epiglottidean fold. For the most part it is smooth and slightly concave, but in its posterior part the mucous membrane bulges out in the form of two elongated vertical elevations placed one behind the other. The anterior elevation is formed by the cuneiform cartilage and a mass of glands associated with it enclosed within the aryteno-epiglottidean fold; the hinder elevation is produced by the anterior margin of the arytenoid cartilage and the cartilage of Santorini. A shallow groove descends between these rounded elevations and terminates below by running into the interval between the false and the true vocal cords. The *posterior wall* of the vestibule is narrow, and corresponds to the interval between the upper parts of the two arytenoid cartilages.

The *superior aperture* of the larynx has already been examined in the dissection of the pharynx (p. 376). The parts which bound it should again be carefully studied.

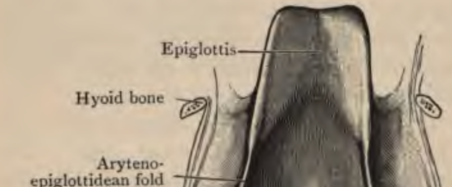
Epiglottis
Hyoid bone
Aryteno-epiglottidean fold
Cushion of epiglottis
Thyroid cartilage
False vocal cord
Laryngeal sinus
True vocal cord
Thyro-arytenoid muscle
Cricoid cartilage

FIG. 147.—Coronal section through Larynx to show Compartments.

The *epiglottis* projects upwards behind the root of the tongue. Its lingual or anterior surface is only free in the upper part of its extent, and is attached to the back part of the tongue by a prominent mesial fold of mucous membrane, termed the *glosso-epiglottidean fold* or *frenum* of the epiglottis. Two lateral folds are also present which connect its margins with the lateral walls of the pharynx; these are called the *pharyngo-epiglottidean folds*. Between the two layers of mucous membrane which constitute each of these three folds, there is a small amount of elastic tissue. The depression on each side between the tongue and the epiglottis which is bounded by the glosso-epiglottidean and the pharyngo-epiglottidean folds is termed the *vallecula* (Fig. 148). The posterior free surface of the epiglottis forms, as we have noted, the greater part of the anterior boundary of the vestibule of the larynx. The upper part of this surface is convex, owing to the manner in which the upper margin is curved forwards towards the tongue; below this there is a slight concavity and still lower a marked bulging or convexity over the upper part of the thyro-epiglottidean ligament. This swelling is called the *tubercle* or *cushion of the epiglottis*, and it forms a conspicuous object in laryngoscopic examinations of the larynx.

The *aryteno-epiglottidean folds* of mucous membrane enclose between their two layers some connective tissue, the aryteno-epiglottidean muscles, and posteriorly the cuneiform cartilages, and the cornicula laryngis which surmount the arytenoid cartilages. As already mentioned, these small nodules of cartilage raise the hinder part of the aryteno-epiglottidean fold in the form of two rounded eminences or tubercles well seen when the larynx is examined by means of the laryngoscope.

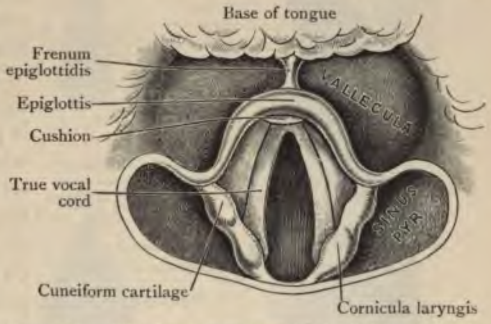

Fig. 148.—The Larynx as seen in the living person by means of the laryngoscope.

The **Middle Subdivision** of the laryngeal cavity (Fig. 147) is the smallest of the three. Above it is bounded by the false vocal cords, below by the true vocal cords, whilst it communicates by the intervals between these folds with the vestibule on the one hand, and the inferior compartment of the larynx on the other.

The *false vocal cords* (plicæ ventriculares) are two prominent mucous folds which extend from before backwards on the side walls of the laryngeal cavity. They are soft and somewhat flaccid, and present a free border which is slightly arched—the concavity looking downwards. Within the fold of mucous membrane which forms this cord are contained—(1) the feeble superior thyro-arytenoid ligament; (2) numerous glands which are chiefly aggregated in its middle part; and (3) a few muscle fibres. The interval between the false vocal cords is sometimes termed the *false glottis*, and is considerably wider than that between the true vocal cords.

It follows from this, that when the cavity of the larynx is examined from above, the four cords are distinctively visible, but when examined from below the true cords alone can be seen.

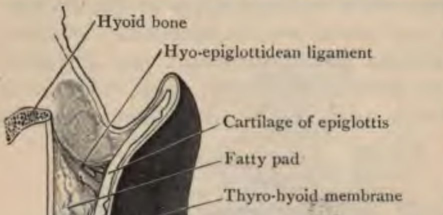
Hyoid bone
Hyo-epiglottidean ligament
Cartilage of epiglottis
Fatty pad
Thyro-hyoid membrane
Thyroid cartilage
Elevation produced by cuneiform cartilage
False vocal cord
Philtrum ventriculi
Elevation produced by arytenoid cartilage
Laryngeal sinus
True vocal cord
Arytenoid muscle
Processus vocalis
Cricoid cartilage
Cricoid cartilage

FIG. 149.—Mesial section through Larynx to show the Outer Wall of the Right Half.

The *true vocal cords* (plicæ vocales), placed below the false cords, extend from the angle between the alæ of the thyroid cartilage in front to the vocal processes of the arytenoid cartilages behind. The true vocal cord is sharp and prominent, and the mucous membrane which is stretched over it is thin and firmly bound down to the subjacent ligament. In colour it is pale, almost pearly white, whilst posteriorly the point of the processus vocalis of the arytenoid cartilage, which stands out in relief, presents a yellowish tinge. In section each true vocal cord is somewhat prismatic in form, and the free border looks upwards and inwards.

The true vocal cords are the agents by means of which the voice is produced. The false vocal cords are of little importance in this respect; indeed, they can in great part be destroyed, and no appreciable difference in the voice result.

The *rima glottidis* or *glottis vera* is the elongated fissure by means of which the middle compartment of the larynx communicates with the lower subdivision. It is placed somewhat below the middle of the laryngeal cavity, of which it constitutes the narrowest part. In front it corresponds to the interval between the true vocal cords; behind it corresponds to the interval between the bases and vocal processes of the arytenoid cartilages (Fig. 150). It is composed, therefore, of two very distinct parts—(1) a narrow anterior portion, between the true vocal cords, involving less than two-thirds of its length, and called the *glottis vocalis* (pars intermembranacea); (2) a broader, shorter portion between the arytenoid cartilages, and termed the *glottis respiratoria* (pars intercartilaginea). The form of the rima glottidis undergoes frequent alterations during life, but during ordinary quiet respiration it is lanceolate in outline. The glottis vocalis presents, under these conditions, the form of an elongated triangle with the base directed backwards. When the glottis is widely opened the broadest part of the fissure is at the extremities of the vocal processes of the arytenoid cartilages, and here the side of the rima presents a marked angle. The two vocal cords, on the other hand, may be approximated so closely to each other, as in singing a high note, that the glottis vocalis is reduced to a linear chink. The length of the entire fissure differs considerably in the

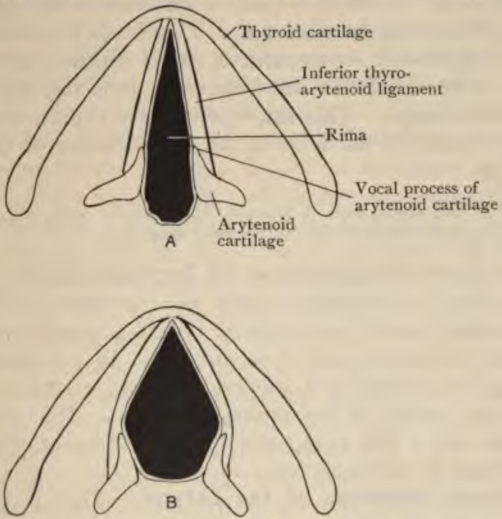
Thyroid cartilage
Inferior thyro-arytenoid ligament
Rima
Vocal process of arytenoid cartilage
Arytenoid cartilage
A
B

FIG. 150.—Diagram of Rima Glottidis.

A. During ordinary easy breathing. B. Widely open.

two sexes. In the male its average length is 23 mm.; in the female, 17 mm.

The side wall of the larynx in the interval between the true and the false vocal cords shows a pocket-like depression or recess, termed the *laryngeal sinus* (ventriculus laryngis). The dissector should endeavour to gauge the extent of this, by means of a probe bent at the extremity. The recess passes upwards, so as to undermine somewhat the false vocal cord, and its mouth or orifice is narrower than its cavity. Under cover of the fore-part of the false vocal cord, a slit-like aperture will be detected. This leads into the *laryngeal saccule* (appendix ventriculi), a small mucous diverticulum, which ascends between the false vocal cord and the ala of the thyroid cartilage. This sac is of variable extent, but as a rule it ends blindly at the level of the upper border of the thyroid cartilage.

Distend the sinus, and if possible the saccule, with cotton wadding. This will greatly facilitate the subsequent dissection.

The **Lower Subdivision of the Laryngeal Cavity** (Fig. 147) leads directly downwards into the trachea. Above, it is narrow and laterally compressed, but it gradually widens out until in its lowest part it is circular. It is bounded by the sloping inner surfaces of the crico-thyroid membrane, and by the inner aspect of the cricoid cartilage. It is through the anterior wall of this compartment that the opening is made in the operation of laryngotomy.

Mucous Membrane of the Larynx.—This is continuous above with that lining the pharynx, and below with the mucous lining of the trachea. Over the laryngeal or hinder surface of the epiglottis it is closely adherent, but elsewhere above the level of the true vocal cords it is loosely attached by submucous tissue. As it passes over the true vocal cords it is very thin and tightly bound down. In inflammatory conditions of the larynx attended by œdema this prevents the infiltration of the submucous tissue extending downwards below the rima glottidis.

The mucous membrane of the larynx has a plentiful supply of racemose glands which secrete mucus. Over the surface of the true vocal cords these are completely absent.

Dissection.—Place the larynx upon a block so that its anterior surface looks upwards, and fix it in this position with pins. The branches which the external laryngeal nerve gives to the crico-thyroid muscle should in the first place be followed out, and carefully preserving the superior and inferior laryngeal vessels and the internal and recurrent laryngeal nerves, the dissector should in the next place proceed to remove the thyroid body, and the omo-hyoid, sterno-hyoid, sterno-thyroid, and thyro-hyoid muscles. The fibres of origin of the inferior constrictor muscle should likewise be cleared away from the thyroid and cricoid cartilages. The broad thyro-hyoid membrane, the central portion of the crico-thyroid membrane, and the crico-thyroid muscles are now exposed, and their attachments may be defined.

Thyro-hyoid Membrane.—This is a broad membranous sheet, which occupies the interval between the hyoid bone and the thyroid cartilage. It is not equally strong throughout, but shows a central thick portion and a cord-like right and left margin, whilst in the intervals between these it is thin and weak. The central thickened part (*ligamentum thyreo-hyoideum medium*) is largely composed of elastic fibres. Above, it is attached to the posterior aspect of the upper margin of the body of the hyoid bone; whilst below, it is fixed to the sides of the deep median notch, which interrupts the superior border of the thyroid cartilage. The upper part of its anterior surface is therefore placed behind the posterior hollowed-out surface of the body of the hyoid bone; a synovial bursa is interposed between them, and in certain movements of the head and larynx the upper border of the thyroid cartilage is allowed to slip upwards behind the hyoid bone. On each side of the strong central part the thyro-hyoid membrane is thin and loose. It is attached below to the upper margin of the ala of the thyroid cartilage, and above to the deep aspect of the great cornu of the hyoid bone. It is pierced by the internal laryngeal nerve and superior laryngeal vessels. The posterior border of the membrane on each side is thickened, rounded, and cord-like (*ligamentum thyreo-hyoideum laterale*), and is chiefly composed of elastic fibres. It extends from the tip of the great cornu of the hyoid bone to the extremity of superior cornu of the thyroid cartilage. In this ligament there is usually developed a small oval cartilaginous or bony nodule, which is termed the *cartilago triticea*.

Crico-thyroid Muscle.—The crico-thyroid muscle is placed on the side of the cricoid cartilage, and bridges over the lateral portion of the crico-thyroid interval. Taking origin from the lower border and outer surface of the anterior arch of the cricoid cartilage, its fibres spread out in an upward and backward direction, and are inserted into the inner aspect of the lower margin of the thyroid cartilage, and also into the anterior border of its inferior cornu. As a general rule, it is divided into two parts. The *anterior* or *oblique part* is composed of those fibres which are attached to the ala of the thyroid cartilage; the *posterior* or *horizontal part* is formed of those fibres which are inserted into the inferior cornu of the thyroid cartilage. It is closely associated with the inferior constrictor muscle. The crico-thyroid muscle is supplied by the *external laryngeal branch* of the superior laryngeal nerve.

Middle Portion of the Crico-thyroid Membrane.—This can be studied in the interval between the two crico-thyroid muscles. It is a tense, elastic, and strong membrane, which is attached below to the median part of the upper border of the anterior arch of the cricoid cartilage, and above to the lower margin of the middle portion of the thyroid cartilage. It is pierced by minute apertures, and is crossed superficially by the crico-thyroid branch of the superior thyroid artery. On each side, under cover of the crico-thyroid muscle, the lateral part of the crico-thyroid membrane presents very different connexions. It is not attached to the lower border of the thyroid cartilage, but stretches upwards into the interior of the larynx, and takes part in the formation of the true vocal cord. At a later stage of the dissection it will be fully exposed.

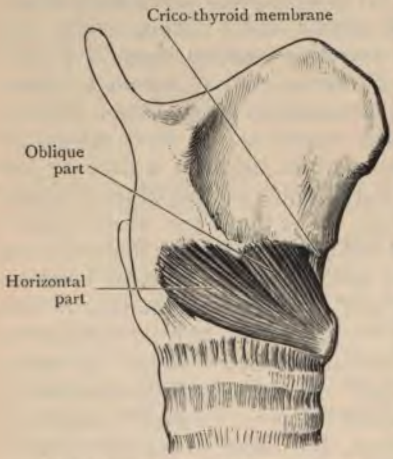

FIG. 151.—The Crico-thyroid Muscle.

Dissection.—The position of the larynx must now be reversed. Fix it upon the block in such a manner that its posterior aspect is directed upwards. The œsophagus should then be slit open by a mesial incision through its posterior wall. Next remove with great care the mucous membrane which covers the posterior aspect of the cricoid and arytenoid cartilages. In doing this, bear in mind that the inferior laryngeal artery, and the recurrent laryngeal nerve, pass upwards between the thyroid and cricoid cartilages, and must be preserved.

Upon the posterior aspect of the broad lamina of the cricoid cartilage the dissector will now note the two posterior crico-arytenoid muscles, and the attachment of the tendinous band through which the longitudinal fibres of the œsophagus are fixed to the cricoid cartilage. This takes origin from the prominent mesial ridge on the back aspect of the cricoid cartilage. On the posterior surface of the arytenoid cartilages, and bridging across the interval between them, the dissector will observe the arytenoid muscle. Especial care must be taken in cleaning this muscle in order that the connexions of the superficial decussating fibres may be fully ascertained.

The outer layer of the right aryteno-epiglottidean fold of mucous membrane should now be cautiously removed. This will expose the aryteno-epiglottidean muscle, the cuneiform cartilage, and the cartilage of Santorini of that side. This is perhaps the most difficult part of the dissection, because the dissector has to establish the continuity of the sparse fibres which compose the pale aryteno-epiglottidean muscle with the decussating fibres of the arytenoid muscle.

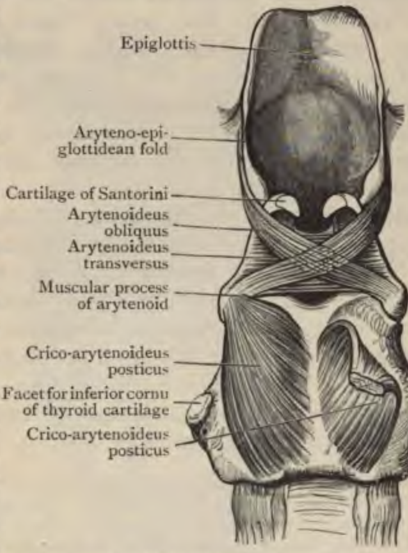
Epiglottis
Aryteno-epiglottidean fold
Cartilage of Santorini
Arytenoideus obliquus
Arytenoideus transversus
Muscular process of arytenoid
Crico-arytenoideus posticus
Facet for inferior cornu of thyroid cartilage
Crico-arytenoideus posticus

FIG. 152.—Muscles on the Posterior Aspect of the Larynx.

Posterior Crico-arytenoid Muscle.—The posterior crico-arytenoid muscle is somewhat fan-shaped (Fig. 152). It springs by a broad origin from the depression which marks the posterior surface of the cricoid cartilage on each side of the mesial ridge, and its fibres converge to be inserted into the posterior surface and outer angle of the processus muscularis or projecting outer angle of the base of the arytenoid cartilage. In pursuing this upward and outward course, the fibres run with different degrees of obliquity. The uppermost fibres are short and nearly horizontal; the intermediate fibres are the longest, and are very oblique; whilst the lowest fibres are almost vertical in their direction.

Arytenoid Muscle.—The arytenoid muscle consists of two portions,—a superficial part, termed the arytenoideus obliquus, and a deeper layer, called the arytenoideus transversus.

The *arytenoideus obliquus* is composed of two bundles of muscular fibres, each of which springs from the posterior aspect of the outer angle of the base or processus muscularis of the corresponding arytenoid cartilage (Fig. 152). From these points the two fleshy slips proceed upwards and inwards, and cross each other in the mesial plane like the limbs of the letter X. Reaching the summit of the arytenoid cartilage on each side, some of the fibres are inserted into it, but the greater proportion are prolonged round the base of the cartilage of Santorini into the aryteno-epiglottidean fold. Here they receive the name of the *aryteno-epiglottidean muscle*, and as they approach the epiglottis they are joined by the fibres of the thyro-epiglottidean muscle. The oblique arytenoid muscles may therefore be considered as constituting a weak sphincter muscle for the superior aperture of the larynx. Each bundle starting from the base of one of the arytenoid cartilages is prolonged into the aryteno-epiglottidean fold of the opposite side, and along this to the margin of the epiglottis.

The *arytenoideus transversus* is an unpaired muscle. It is composed of transverse fibres which bridge across the interval between the two arytenoid cartilages, and are attached to the posterior aspect of the outer border of the arytenoid cartilage. Many of the fibres turn round the arytenoid cartilage and become continuous on each side with the fibres of the thyro-arytenoid muscle.

Dissection.—The further dissection of the laryngeal muscles should be confined to the right side of the larynx. The left side should be reserved for the study of the nerves and vessels. Place the larynx on its left side, and, having fixed it in this position, remove the right crico-thyroid muscle. The right lateral thyro-hyoid ligament should next be divided, and the right inferior cornu of the thyroid cartilage disarticulated from its facet on the side of the cricoid cartilage. An incision should now be made through the right ala of the thyroid cartilage a short distance to the outer side of the mesial plane, and the detached piece carefully removed. Three muscles are now exposed, and must be carefully cleaned and defined. They are named from below upwards:—

1. The lateral crico-arytenoid.
2. The thyro-arytenoid.
3. The thyro-epiglottidean.

Lateral Crico-arytenoid Muscle.—The lateral crico-arytenoid muscle is triangular in form, and smaller than the crico-arytenoideus posticus (Fig. 153). It springs from the upper border of the lateral part of the cricoid cartilage as far back as the facet which supports the base of the arytenoid cartilage; a few of its fibres likewise take origin from the crico-thyroid membrane. From this attachment its fibres run backwards and upwards, and converge to be inserted into the anterior surface of the processus muscularis or outer projecting angle of the base of the arytenoid cartilage. The superficial or outer surface of this muscle is covered by the ala of the thyroid cartilage and the upper part of the crico-thyroid muscle; its deep surface is applied to the lateral part of the crico-thyroid membrane.

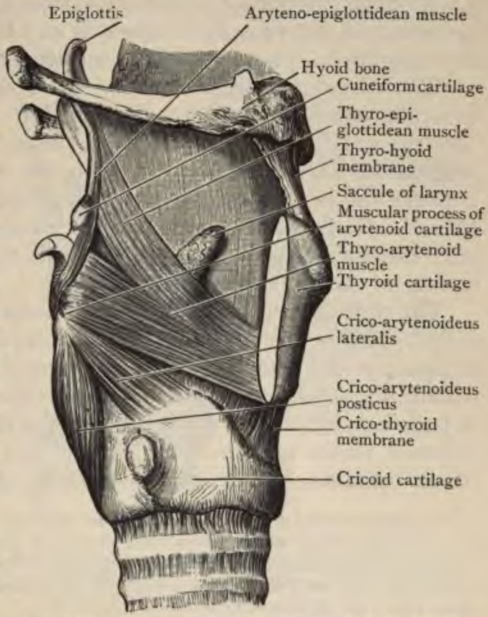
Epiglottis
Aryteno-epiglottidean muscle
Hyoid bone
Cuneiform cartilage
Thyro-epiglottidean muscle
Thyro-hyoid membrane
Saccule of larynx
Muscular process of arytenoid cartilage
Thyro-arytenoid muscle
Thyroid cartilage
Crico-arytenoideus lateralis
Crico-arytenoideus posticus
Crico-thyroid membrane
Cricoid cartilage

FIG. 153.—Muscles in the Lateral Wall of Larynx.

Thyro-arytenoid Muscle.—This is a muscular sheet which is placed above the crico-arytenoideus lateralis (Fig. 153). The contiguous margins of these muscles are sometimes found so intimately blended that it is impossible to effect a natural separation.

The thyro-arytenoid muscle is usually described as consisting of a superficial and a deep portion, termed respectively the thyro-arytenoideus externus and internus. These two parts are as a general rule inseparably united, and can only be isolated from each other by artificial means.

The *thyro-arytenoideus externus* is a broad muscular layer which lies immediately subjacent to the ala of the thyroid cartilage. Its lower border is in contact with the lateral crico-arytenoid muscle, whilst its upper border is placed at a higher level than the true vocal cord. Its upper part, therefore, is in relation to the wall of the laryngeal sinus.

The thyro-arytenoideus externus arises in front from the lower half of the inner surface of the ala of the thyroid cartilage, close to the angle, and also from the lateral part of the crico-thyroid membrane, on which it to some extent lies. Its fibres pass backwards and are inserted into the outer border and muscular process of the arytenoid cartilage, a certain number, however, turning round this cartilage and becoming continuous with the arytenoideus transversus muscle.

A certain proportion of the uppermost fibres of the thyro-arytenoideus externus curve upwards and backwards to reach the epiglottis. These constitute the *thyro-epiglottidean muscle*.

The *thyro-arytenoideus internus* is a slender three-sided muscular band which is closely applied to the outer side of the true vocal cord, and receives its prismatic form from this adaptation. It arises in front from the angular depression between the two alæ of the thyroid cartilage, and is inserted behind into the outer aspect of the processus vocalis, and also into the adjoining depressed part of the antero-external surface of the arytenoid cartilage.

The thyro-arytenoideus internus is thicker behind than in front. This is due to the fact that whilst all the fibres which compose it are attached to the arytenoid cartilage, only a certain proportion obtain attachment to the thyroid cartilage. A large number of the deeper fibres are directly attached at different points to the outer side of the true vocal cord. These constitute the *ary-vocalis muscle* (Ludwig).

A muscle termed the *thyro-arytenoideus superior* is frequently present. It is a slender band which arises from the inner aspect of the ala of the thyroid cartilage close to the notch, and passes backwards and downwards to find insertion into the lateral border of the arytenoid cartilage immediately above the processus muscularis.

Dissection.—The lateral crico-arytenoid muscle should now be carefully removed, and at the same time the dissector should endeavour to disengage the fibres of the thyro-arytenoideus externus from the deeper thyro-arytenoideus internus, in order that the relation of the latter to the true vocal cord may be studied. Finally remove the entire thyro-arytenoid muscle. This will display the outer surface of the lateral part of the crico-thyroid membrane, the true vocal cord or inferior thyro-arytenoid ligament, and the wall of the laryngeal sinus. By carefully dissecting between the two layers of mucous membrane which clothe the false vocal cord, the weak superior thyro-arytenoid ligament which gives it support may be discovered, as well as a number of racemose glands which lie in relation to it.

Lateral Part of the Crico-thyroid Membrane.—The central part of the crico-thyroid membrane, as we have noted, closes in front the interval between the cricoid and thyroid cartilages. On each side, however, the lateral part of the same membrane is not attached to the lower border of the thyroid cartilage, but slopes upwards and inwards, and very materially diminishes the transverse width of the lower subdivision of the laryngeal cavity in its upper part. The attachments which it effects are very definite. *Below*, it is fixed to the upper border of the cricoid cartilage, immediately subjacent to the mucous membrane; *in front*, it is attached to the lower half of the inner surface of the ala of the thyroid cartilage, close to the angle; and *behind*, to the lower border of the processus vocalis of the arytenoid cartilage. *Above*, it is directly continuous with the *inferior thyro-arytenoid ligament* or true vocal cord. The latter, indeed, may be looked upon as constituting its upper, thickened, free border. In contact with its outer surface are the lateral crico-arytenoid and the thyro-arytenoid muscles, whilst its inner surface is clothed by the lining mucous membrane of the larynx.

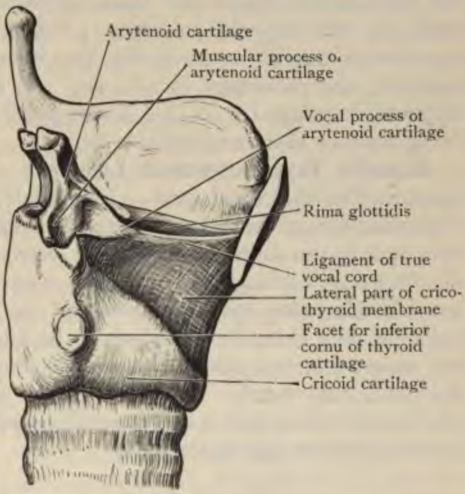
Arytenoid cartilage
Muscular process of arytenoid cartilage
Vocal process of arytenoid cartilage
Rima glottidis
Ligament of true vocal cord
Lateral part of crico-thyroid membrane
Facet for inferior cornu of thyroid cartilage
Cricoid cartilage

FIG. 154.—Lateral part of Crico-thyroid Membrane. The right ala of the thyroid cartilage has been removed.

Inferior Thyro-arytenoid Ligament.—This ligament is formed in connexion with the upper free border of the lateral part of the crico-thyroid membrane, and it constitutes the support of the true vocal cord. It is attached in front, close to its fellow of the opposite side, to the middle of the angular depression between the two alæ of the thyroid cartilage. From this it stretches backwards, and is fixed behind to the tip and upper border of the processus vocalis, which projects forwards from the base of the arytenoid cartilage. The inferior thyro-arytenoid ligament is composed of yellow elastic fibres. Its inner border is sharp and free, and is clothed by mucous membrane, which in this position is thin and firmly bound down to the ligament. Embedded in its anterior extremity there is a minute nodule of condensed elastic tissue.

By removing the mucous membrane which lines the bottom of the laryngeal sinus the dissector will obtain a good view of the parts which bound the rima glottidis—viz., *in front*, the angle of the thyroid cartilage; *behind*, the arytenoideus transversus muscle; *on each side*, the inferior thyro-arytenoid ligament, the processus vocalis, and the inner surface of the arytenoid cartilage (p. 413). These parts are clothed by the lining mucous membrane of the larynx.

Superior Thyro-arytenoid Ligament.—This feeble band supports the false vocal cord. It is weak and indefinite, but somewhat longer than the preceding ligament. In front it is attached to the angular depression between the two alæ of the thyroid cartilage, above the true vocal cords, and immediately below the attachment of the thyro-epiglottidean ligament, and extends backwards to be fixed to a tubercle on the antero-external surface of the arytenoid cartilage above the processus vocalis. It is composed of connective tissue and elastic fibres, which are continuous with the fibrous tissue in the aryteno-epiglottidean fold.

Dissection.—Remove the remains of the aryteno-epiglottidean fold, the vocal cords, and the lateral part of the crico-thyroid membrane on the right side of the larynx, but be careful not to injure the arytenoid cartilage and the cartilage of Santorini. Should the cuneiform cartilage be present in the aryteno-epiglottidean fold it should be detached and preserved. By this dissection a closer view of the side wall of the laryngeal cavity can be obtained. The undissected vocal cords of the left side should again be examined, the laryngeal sinus and pouch explored, and their precise connexions and extent determined. When the student has satisfied himself upon these points he can proceed to display the vessels and nerves of the larynx. The superior laryngeal artery and the internal laryngeal nerve reach the larynx by piercing the outer thin part of the thyro-hyoid membrane. By applying traction to the nerve, and at the same time dividing the mucous membrane upon the inner surface of the thyro-hyoid ligament, they can easily be discovered. In following the branches into which they divide, the mucous membrane must be gradually removed from the inner wall of the larynx. The inferior laryngeal artery and nerve enter from below, and proceed upwards, under cover of the ala of the thyroid cartilage. They can only be satisfactorily displayed by the removal of this piece of cartilage, but the dissector is not recommended to adopt this method unless another larynx is available for the examination of the cartilages and joints. By drawing the thyroid cartilage well outwards the more important branches can be studied.

Internal Laryngeal Nerve.—In the dissection of the neck this nerve has been observed to arise from the superior laryngeal branch of the vagus. It is a sensory nerve, and its branches are chiefly distributed to the mucous membrane of the larynx. Piercing the lateral part of the thyro-hyoid ligament, it divides into three branches. The *uppermost* of these sends filaments to the aryteno-epiglottidean fold, to the mucous membrane which covers the epiglottis, and to the three folds in front of it. The twigs which go to the epiglottis ramify on its posterior surface, but many of them pierce the cartilage to reach the mucous membrane on its anterior surface. The *intermediate branch* of the internal laryngeal nerve breaks up into filaments, which are given to the mucous membrane lining the side wall of the larynx. The *lowest branch* descends and gives filaments to the mucous membrane which covers the outer and back aspects of the arytenoid and cricoid cartilages. A well-marked twig proceeds from this branch and runs downwards upon the posterior aspect of the cricoid cartilage to join the recurrent laryngeal nerve.

Recurrent Laryngeal Nerve. — The recurrent laryngeal nerve has previously been seen to arise from the vagus, and it has been traced in the neck up to the point where it disappears under cover of the lower border of the inferior constrictor muscle. It is now observed to ascend upon the outer aspect of the cricoid cartilage, immediately behind the crico-thyroid joint. Here it is joined by the communicating twig from the internal laryngeal nerve, and almost immediately afterwards it divides into two branches. The *larger* of these proceeds upwards under cover of the ala of the thyroid cartilage, and breaks up into filaments which supply the lateral crico-arytenoid, the thyro-arytenoid, and the thyro-ary-epiglottidean muscles; the *smaller* or *posterior branch* inclines upwards and backwards upon the posterior aspect of the cricoid cartilage, and under cover of the posterior crico-arytenoid muscle. It supplies twigs to this muscle, and is then continued onwards to end in the arytenoid muscle.

The recurrent laryngeal nerve is therefore the motor nerve of the larynx. It supplies all the muscles with the exception of the crico-thyroid, which draws its nerve-supply from the external laryngeal. The recurrent laryngeal nerve, however, is usually considered to contain a few sensory fibres. These it gives to the mucous membrane of the larynx below the rima glottidis.

Laryngeal Arteries.—The *superior laryngeal artery*, a branch of the superior thyroid, accompanies the internal laryngeal nerve; the *inferior laryngeal artery* which springs from the inferior thyroid accompanies the recurrent laryngeal nerve. These two vessels ramify in the laryngeal wall and supply the mucous membrane, glands, and muscles.

Laryngeal Cartilages and Joints.—The cartilages which constitute the skeleton of the larynx and give support to its wall are the following:—

1. Thyroid, 2. Cricoid, 3. Cartilage of the epiglottis,	single.	4. Arytenoid, 5. Cornicula laryngis or cartilages of Santorini, 6. Cuneiform,	paired.

They are held together by certain ligaments and joints.

Dissection.—The mucous membrane and muscles must be carefully removed from the cartilages, and the epiglottidean, crico-thyroid, and crico-arytenoid ligaments defined. Great caution must be exercised in cleaning the arytenoid cartilages and the cartilages of Santorini, in order that the latter may not be injured.

Cartilage of the Epiglottis (cartilago epiglottica).—This is a thin leaf-like lamina of yellow fibro-cartilage which is placed behind the tongue and the body of the hyoid bone and in front of the upper aperture of the larynx. When divested of the mucous membrane which covers it behind and also to some extent in front, the epiglottidean cartilage is seen to present the form of a bicycle-saddle and to be indented by pits and pierced by numerous perforations. In the former, glands are lodged; whilst through the latter, vessels, and in some cases nerves, pass. The broad end of the cartilage is directed upwards and is free; its margins are to a large extent enclosed within the aryteno-epiglottidean folds. The anterior surface is only free in its upper part. This part is covered by mucous membrane and looks towards the base of the tongue. The posterior surface is covered throughout its whole extent by the mucous membrane of the larynx. The pointed lower end of the cartilage is carried downwards in the form of a stout fibrous band, termed the thyro-epiglottidean ligament.

***Epiglottidean* Ligaments.**—The epiglottis is bound by ligaments to the base of the tongue, to the side wall of the pharynx, to the hyoid bone, and to the thyroid cartilage. The *glosso-epiglottidean fold* and the two *pharyngo-epiglottidean folds* have already been studied. In each there is a small quantity of elastic tissue. The *hyo-epiglottidean ligament* is a short, broad elastic band which connects the anterior face of the epiglottis to the upper border of the body of the hyoid bone. The *thyro-epiglottidean ligament* is strong, elastic, and thick. It proceeds downwards from the lower pointed extremity of the epiglottis, and is attached to the angular depression between the two alæ of the thyroid cartilage, below and behind the median notch.

The triangular interval which is left between the lower part of the cartilage of the epiglottis and the thyro-hyoid membrane contains a pad of soft fat, and is imperfectly closed above by the hyo-epiglottidean ligament.

Thyroid (cartilago thyreoidea).—This is the largest of the laryngeal cartilages. It is composed of two broad somewhat quadrilateral plates, termed the *alæ*, which meet in front at an angle, and become fused along the mesial plane. Behind, the alæ diverge from each other, and enclose a wide angular space which is open behind. The *anterior borders* of the alæ are only fused in their lower parts. Above they are separated by a deep, narrow V-shaped notch called the *incisura thyreoidea.* In the adult male the angle formed by the meeting of the anterior borders of the two alæ, especially in the upper part, is very projecting, and with the margins of the thyroid notch, which lies above, constitutes a marked subcutaneous prominence in the neck, which receives the name of the *pomum Adami.* The *posterior border* of each ala is thick and rounded, and is prolonged beyond the superior and inferior borders in the form of two slender cylindrical processes termed the cornua. The *superior cornu* is longer than the inferior cornu, and gives attachment to the lateral thyro-hyoid ligament. The shorter, stronger *inferior cornu* curves slightly inwards. On the inner aspect of its tip there is a facet which articulates with the side of the cricoid cartilage. The *superior border* of the ala is for the most part slightly convex, and in front it dips down to become continuous with the margin of the thyroid notch. The *inferior border* is to all intents and purposes horizontal, but it is marked off by a projection, termed the *inferior tubercle*, into a short posterior part and a longer anterior part.

The *outer surface* of the ala is flat. Immediately below the posterior part of the upper border and in front of the root of the superior cornu there is a distinct prominence called the *superior tubercle.* From this an oblique ridge descends towards the inferior tubercle on the lower border of the ala. This ridge gives attachment to the sterno-thyroid and thyro-hyoid muscles, and divides the outer surface of the ala into an anterior and a posterior part. To the latter, which is much the smaller of the two, is attached the inferior constrictor muscle of the pharynx. The *inner surface* of the ala is smooth and slightly concave. To the angular depression between the two alæ are attached the thyro-epiglottidean ligament, the superior thyro-arytenoid ligaments, and the inferior thyro-arytenoid ligaments.

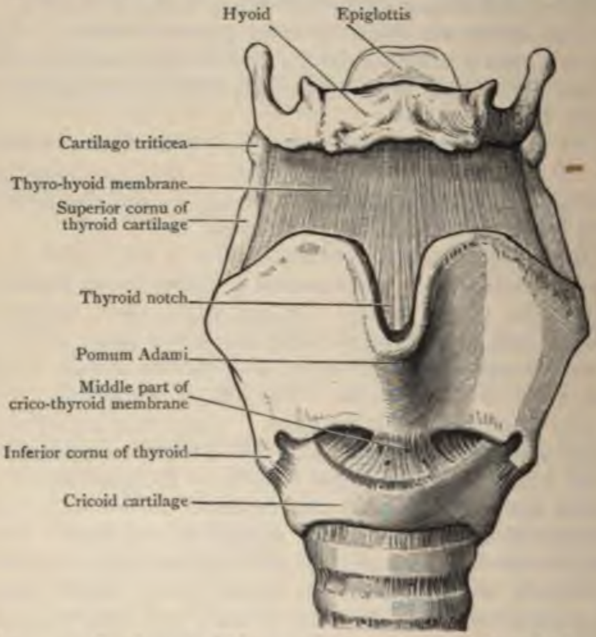
Hyoid
Epiglottis
Cartilago triticea
Thyro-hyoid membrane
Superior cornu of thyroid cartilage
Thyroid notch
Pomum Adami
Middle part of crico-thyroid membrane
Inferior cornu of thyroid
Cricoid cartilage

FIG. 155.—Cartilages and Ligaments of Larynx viewed from the front.

Crico-thyroid Joints.—The articulation on each side between the tip of the inferior cornu of the thyroid cartilage *and the side* of the cricoid cartilage, belongs to the diarthrodial variety. The opposed surfaces are surrounded by a capsular ligament which is lined by a synovial membrane. The movements which take place at these joints are of a twofold character—viz., (1) gliding; (2) rotatory. In the first case the thyroid facets glide upon the cricoid surfaces in different directions. The rotatory movement is one in which the thyroid cartilage rotates around a transverse axis which passes through the centre of the two joints. The capsular ligament is strengthened by a stout band on the posterior aspect of the joint.

The thyroid cartilage should now be removed by dividing the ligaments which surround the crico-thyroid joint.

Cricoid Cartilage (cartilago cricoidea).—This is shaped like a signet ring. The broad *posterior lamina* is somewhat quadrilateral in form. Its superior border presents a faintly marked mesial notch, and on each side of this there is an oval convex facet which articulates with the base of the arytenoid cartilage. The posterior surface of the lamina is divided by an elevated median ridge into two slightly hollowed-out areas which give attachment to the posterior crico-arytenoid muscles. The mesial ridge itself gives origin to a tendinous band which proceeds upwards from the longitudinal fibres of the œsophagus. In front of the posterior lamina the ring of the cricoid cartilage is completed by an *anterior arch*. The lower border of this is horizontal, and is connected to the first tracheal ring by membrane.

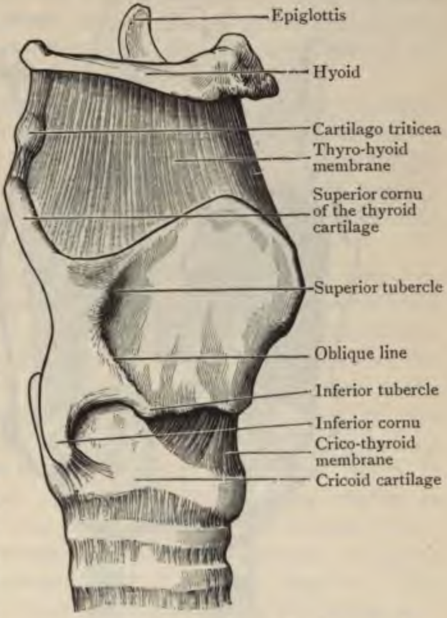
Epiglottis
Hyoid
Cartilago triticea
Thyro-hyoid membrane
Superior cornu of the thyroid cartilage
Superior tubercle
Oblique line
Inferior tubercle
Inferior cornu
Crico-thyroid membrane
Cricoid cartilage

FIG. 156.—Profile view of Cartilages and Ligaments of Larynx.

The arch is narrow in front, and is attached to the lower border of the thyroid cartilage by the middle portion of the crico-thyroid membrane. Behind, the upper border rapidly ascends. Upon the posterior part of the lateral surface of the cricoid cartilage there is a circular, slightly elevated, convex facet, which looks outwards and upwards for articulation with the inferior cornu of the thyroid cartilage. Internally the cricoid cartilage is lined by mucous membrane. Inferiorly the lumen is circular, but above it is elliptical.

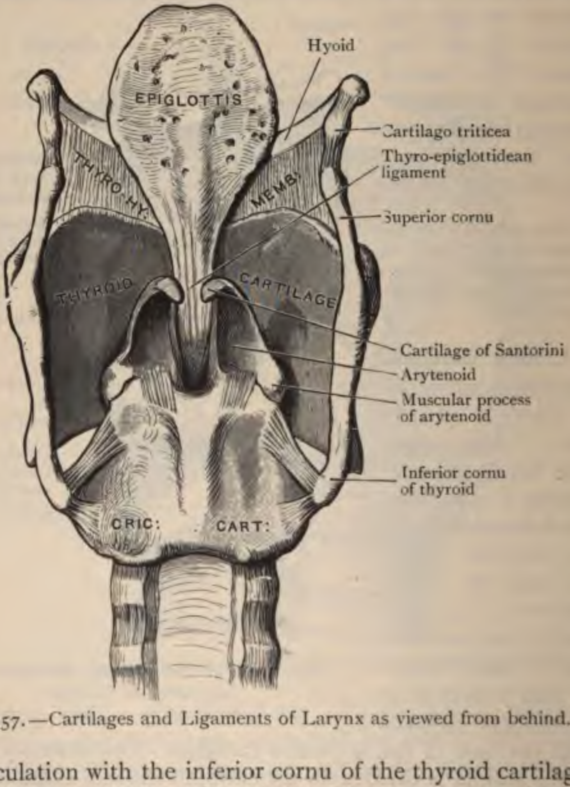
Hyoid
EPIGLOTTIS
Cartilago triticea
Thyro-epiglottidean ligament
THYRO-HY.
MEMB.
Superior cornu
THYROID
CARTILAGE
Cartilage of Santorini
Arytenoid
Muscular process of arytenoid
Inferior cornu of thyroid
CRIC:
CART:

FIG. 157.—Cartilages and Ligaments of Larynx as viewed from behind.

The narrow band-like part of the anterior arch of the cricoid cartilage lies below the lower border of the thyroid cartilage, whilst the posterior lamina is received into the interval between the posterior portions of the alæ of the thyroid cartilage.

Cartilages of Santorini (cartilagines corniculatæ).—Before proceeding to the study of the arytenoid cartilages the dissector should examine the cartilages of Santorini and the manner in which they are held in position. They are two minute pyramidal nodules of yellow elastic cartilage which are placed on the summits of the arytenoid cartilages, and are directed backwards and inwards. Each cartilage of Santorini is enclosed within the corresponding aryteno-epiglottidean fold of mucous membrane, and is joined to the apex of the arytenoid cartilage by a joint which may either partake of the nature of diarthrosis or synchondrosis.

Arytenoid Cartilages (cartilagines arytænoideæ).—In dealing with the arytenoid cartilages it is well to remove one in order that its external form may be studied; the other should be retained in position for the purpose of afterwards examining the crico-arytenoid joint, and the movements which can be performed at this articulation.

The *arytenoid cartilages* are pyramidal in form, and surmount the upper border of the posterior lamina of the cricoid cartilage. The *apex* of each is directed upwards, and at the same time curved backwards and inwards. It supports the cartilage of Santorini. Of the three surfaces, one looks directly inwards towards the corresponding surface of the opposite cartilage, from which it is separated by a narrow interval; another looks backwards; whilst the third is directed outwards and forwards. The *internal surface* is narrow, vertical, and even, and is clothed by mucous membrane. The *posterior surface* is concave; it lodges and gives attachment to the arytenoideus transversus muscle. The *antero-external surface* is the most extensive of the three, and is uneven for muscular and ligamentous attachments. Upon this aspect of the arytenoid cartilage the thyro-arytenoid muscle is inserted, whilst a small tubercle placed a short distance above the base gives attachment to the superior thyro-arytenoid ligament—the supporting ligament of the false vocal cord. The surfaces of the arytenoid cartilage are separated by three borders, viz., an anterior, a posterior, and an external. The *external border* is the longest, and at the base of the cartilage it is prolonged outwards and backwards in the form of a stout prominent angle or process, termed the *processus muscularis*. Into the front of this the crico-arytenoideus lateralis muscle is inserted; into its posterior aspect the crico-arytenoideus posticus muscle is inserted. The *anterior border* of the arytenoid cartilage is prolonged into the projecting anterior angle of the base. This is called the *processus vocalis.* It is sharp and pointed, is directed horizontally forwards, and gives attachment to the inferior thyro-arytenoid ligament or true vocal cord. The *base* of the arytenoid cartilage presents an elongated concave facet on its under aspect for articulation with the upper border of the posterior lamina of the cricoid cartilage.

Crico-arytenoid Joints.—These articulations are of the diarthrodial variety. There is a distinct joint cavity surrounded by a capsular ligament which is lined by a synovial membrane. The cricoid articular surface is convex, that of the arytenoid concave; both are elongated in form, but they are placed in relation to each other, so that the long axis of the one intersects or crosses that of the other, and in no position of the joint do the two surfaces accurately coincide; a portion of the cricoid surface is always left uncovered. The movements allowed at this joint, as the dissector can readily determine, are of a twofold kind—(1) *gliding*, by which the arytenoid is carried inwards or outwards, or, in other words, a movement by which the arytenoid advances towards or retreats from its fellow; (2) *rotatory*, by which the arytenoid cartilage revolves round a vertical axis. By this movement the vocal process is swung outwards or inwards, so as to open or close the rima glottidis.

The dissector should note that the capsule of this joint is strengthened behind by a strong band which plays a most important part in the mechanism of the articulation. It acts in such a manner that it arrests forward movement of the arytenoid cartilage.

Cuneiform Cartilages (cartilagines cuneiformes).—These are two little rod-shaped nodules of yellow elastic cartilage, which are placed one in each aryteno-epiglottidean fold near its back part. They are not always present.

Action of the Laryngeal Muscles.—The dissector should now consider the manner in which the muscles of the larynx operate upon the true vocal cords in the production of the voice. *Tension* of the vocal cords is produced by the contraction of the *crico-thyroid muscles.* The anterior or oblique parts of the muscles pull the lower border of the thyroid cartilage downwards, whilst the posterior horizontal portions, through their insertions into the inferior cornua, draw the thyroid cartilage forwards, thereby increasing the distance between the angle of the thyroid cartilage and the vocal processes of the arytenoid cartilages. When the crico-thyroid muscles cease to contract, the relaxation of the cords is brought about by the elasticity of the ligaments. The *thyro-arytenoid muscles* must be regarded as antagonistic to the crico-thyroid muscles. When they contract they approximate the angle of the thyroid cartilage to the arytenoid cartilages, and still further relax the cords, and when they cease to act, the elastic ligaments of the larynx again bring about a state of equilibrium. The *ary-vocales* muscles, by the insertion of their fibres into the true vocal cords, may tighten portions of the cords, and, at the same time, relax the parts behind.

The *width of the rima glottidis* is regulated by the arytenoideus muscle, which draws together the arytenoid cartilages. The lateral and posterior crico-arytenoid muscles also modify the width of the rima glottidis. When they act together they assist the arytenoid muscle in closing the glottis, but when they act independently they are antagonistic muscles. Thus the *crico-arytenoidei postici*, by drawing the muscular processes of the arytenoid cartilages outwards and backwards, swing the processus vocales and the vocal cord outwards, and thus open the rima. The *crico-arytenoidei laterales* act in exactly the opposite manner. By drawing the muscular processes in an opposite direction, they close the rima.

But the muscles of the larynx have another function to perform besides that of vocalisation. It was formerly thought that the superior aperture of the larynx was closed during deglutition by the folding back of the epiglottis; that in fact the epiglottis, during the passage of the bolus of food, was applied like a lid over the entrance to the vestibule of the larynx. The investigations of Prof. Anderson Stuart, however, have rendered it likely that the superior aperture of the larynx is closed during swallowing by the close application and the forward folding of the two arytenoid cartilages, so that their apices become closely applied to the cushion of the epiglottis. The muscles chiefly concerned in this movement are the external thyro-arytenoid muscles and the transverse arytenoid muscle. These muscles form a true sphincter vestibuli. The thyro-ary-epiglottidean muscle also assists in the closure.

THE TONGUE.

The tongue is a muscular organ placed on the floor of the mouth. It has important duties to perform in connexion with the functions of mastication, deglutition, and articulation. Moreover, the mucous membrane which covers it is specially modified in certain localities in connexion with the peripheral terminations of the nerves of taste. The root of the tongue is attached to the hyoid bone; in front, the pointed extremity is free; whilst the dorsal aspect of its base forms the lower boundary of the isthmus faucium.

Mucous Membrane.—The lingual mucous membrane is a part of the general mucous lining of the buccal cavity.

The *dorsum of the tongue*, when the mouth is closed and the organ is at rest, is strongly arched from before backwards, and for the most part is moulded into the vaulted roof of the mouth. The tongue consists of two developmentally distinct parts, termed respectively buccal and pharyngeal. These are marked off from each other, even in the adult, by a V-shaped groove called the *sulcus terminalis*. The apex of this sulcus points backwards, and coincides with a median blind pit which receives the name of the *foramen cæcum*. From this the two limbs of the sulcus diverge outwards and forwards, and they reach the margins of the organ where the anterior pillars of the fauces find attachment to the tongue.

The *buccal part* of the tongue, by its upper or dorsal surface, stands in relation to the hard palate, and to some extent also to the front portion of the soft palate. The *pharyngeal part* of the tongue looks backwards, and forms the anterior wall of the oral portion of the pharynx. In its upper part it is related to the soft palate, whilst below it is intimately related to the epiglottis. On the side wall of the pharynx, immediately above this portion of the tongue, is the tonsil.

The mucous membrane which envelops the tongue is a part of the general mucous lining of the buccal cavity, and it presents very different appearances in different localities. That portion which is spread over the pharyngeal part of the tongue, and which on either side is prolonged upwards over the surface of the tonsil, exhibits a very characteristic appearance. It is smooth and somewhat glossy, and presents no visible papillæ. It is from this district that the middle glosso-epiglottidean fold takes origin, and every here and there the surface is studded with low projections which are produced by lymphoid follicles placed subjacent to the mucous membrane. Each of these small elevated areas, as a rule, presents in the centre a minute pit, visible to the naked eye.

In front of the foramen cæcum and sulcus terminalis the mucous membrane which covers the dorsum, sides, and tip of the buccal part of the tongue is beset with papillæ of different kinds. As these are individually visible to the naked eye, the mucous membrane presents a very characteristic appearance. Further, a mesial groove or sulcus called the *raphe* extends backwards from the tip of the tongue to the foramen cæcum, and divides the anterior two-thirds of the dorsum into two lateral parts.

On the under surface of the tongue the mucous membrane is smooth and comparatively thin. In the mesial plane it forms the *frenum linguæ*, which has been studied at an earlier stage. On either side of the median line the lingual vein may be noticed in the living subject stretching forwards towards the tip. To the outer side of this, and, therefore, somewhat nearer the border of the tongue, is a delicate and feebly marked fold of mucous membrane, from the free border of which a row of fringe-like processes or fimbriæ project. It is termed the *plica fimbriata*, and, as it extends forwards towards the tip of the tongue, it inclines towards the mesial plane and its neighbour of the opposite side. On the side of the tongue, immediately in front of the lingual attachment of the anterior pillar of the fauces, five short vertical fissures in the mucous membrane, separated by intervening folds, may be noticed. This arrangement is termed the *papilla foliata*. It is the representative of a leaf-like condition of the mucous membrane, which is much more highly developed in certain of the lower animals (hare and

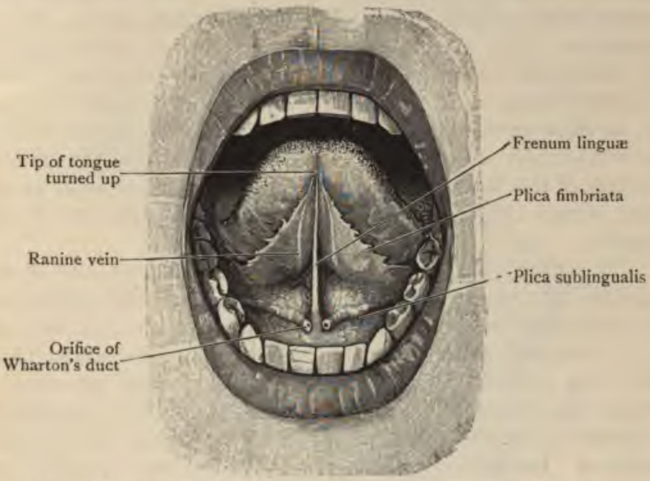

FIG. 158.—The Sublingual Region in the Interior of the Mouth.

rabbit), and which is specially concerned in receiving the impressions of taste.

Lingual Papillæ (papillæ linguales).—These are of three kinds, and differ in size, shape, and in the position they occupy on the surface of the tongue. They are termed the circumvallate, the fungiform, and the conical.

The *circumvallate papillæ* (papillæ vallatæ), seven to twelve in number, are the largest, and are placed immediately in front of the sulcus terminalis in two rows, which diverge from each other in an outward and forward direction, like the two limbs of the letter V. The foramen cæcum lies immediately behind the median circumvallate papilla, which forms the apex of the V. In form a circumvallate papilla is broad and somewhat cylindrical, slightly narrower at its attached than at its free extremity, and it is sunk in a pit. It is thus surrounded by a deep trench, the outer wall or which, termed the *vallum*, is slightly raised beyond the general surface of the mucous membrane, and forms an annular elevation which encircles the free extremity or summit of the papilla.

The *fungiform papillæ* (papillæ fungiformes) are much smaller, but are present in much greater numbers. They are chiefly found on the tip and sides of the tongue, but they are also scattered at irregular intervals over the dorsum. They are very characteristic in form. Each papilla presents a large, full, rounded knob-like extremity, while it is greatly constricted at the point where it springs from the mucous surface. In the living tongue the fungiform papillæ are distinguished by their bright red colour.

The *conical papillæ* (papillæ conicæ) are present in very large numbers. They are smaller than the fungiform variety, and although they are quite visible to the naked eye, they can be more conveniently studied by the aid of an ordinary pocket lens. They are minute conical projections which taper towards their free extremities, and occupy the dorsum and sides of the tongue in front of the sulcus terminalis. They are arranged in parallel rows which are placed close together, and in the back part of the tongue these diverge from the mesial raphe in a forward and outward direction. Towards the tip of the tongue the rows of conical papillæ become more or less transverse in direction, and on the sides of the tongue they are arranged perpendicularly.

Muscles of the Tongue.—The tongue is almost entirely composed of muscular fibres, with some adipose tissue intermixed. It is divided into two lateral halves by a mesial septum, and the muscles in connexion with each of these consist of an intrinsic and an extrinsic group. They are as follows:—

Extrinsic Muscles,
  1. Genio-hyo-glossus.
  2. Hyo-glossus.
  3. Chondro-glossus.
  4. Stylo-glossus.
  5. Palato-glossus.

Intrinsic Muscles,
  1. Superficial lingual.
  2. Inferior lingual.
  3. Vertical.
  4. Transverse.

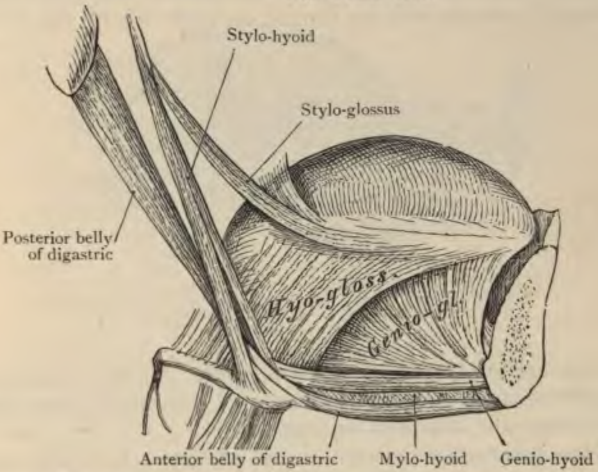

FIG. 159.—Muscles of the Tongue. (From Gegenbaur.)

The *extrinsic muscles* take origin from parts outside the tongue, and thus are not only capable of giving rise to changes in the form of the organ, but also of producing changes in its position. The *intrinsic muscles*, which are placed entirely within the substance of the tongue, are, for the most part, only capable of giving rise to alterations in its form.

With the exception of the chondro-glossus, the extrinsic muscles have already been studied, but the dissector should take this opportunity of examining more fully their insertions, and the manner in which their fibres are related to each other and to those of the intrinsic muscles. For this purpose carefully reflect the mucous membrane from the right half of the tongue, and follow the muscles into that side of the organ. At the same time the lingual nerves and the ranine artery should be preserved. On the under surface of the tongue near the tip, the removal of the mucous membrane will expose a group of glands aggregated together, so as to form a small oval mass on each side of the mesial plane. This is known as the *apical gland* or the *gland of Nühn.*

The *stylo-glossus* will be observed to run along the side of the tongue to the tip, where the two muscles become to a certain extent continuous. The *hyo-glossus* extends upwards to the side of the tongue, and its fibres pass for the most part under cover of those of the stylo-glossus to reach the dorsum, over the posterior part of which they spread out beneath the mucous membrane. The *genio-hyo-glossus* sends its fibres vertically upwards into the tongue on each side of the mesial septum, and its insertion stretches from the tip to the base. The fibres of the *palato-glossus* become continuous with those which form the stratum transversum.

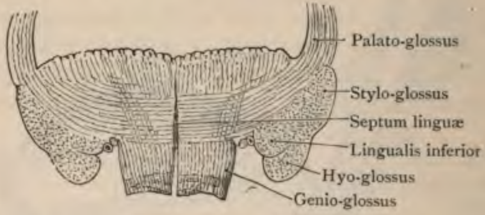

FIG. 160.—Transverse section through the hinder part of the Tongue. (From Gegenbaur.)

The *chondro-glossus* is not always present. It is separated from the deep surface of the hyo-glossus by the lingual vessels, and by the pharyngeal slip of the genio-hyo-glossus. It is a slender muscular band which takes origin from the inner aspect of the root of the lesser cornu, and the adjoining part of the body of the hyoid bone. Its fibres ascend to enter the tongue, and finally spread out on the dorsum under cover of the lingualis superior.

The *superficial lingual muscle* (musculus longitudinalis superior) is a continuous layer of longitudinal fibres which covers the entire dorsum linguæ, from the root to the tip, immediately beneath the mucous membrane. Towards the base of the tongue it is thinner than in front, and here it is overlapped by the transverse fibres of the hyo-glossus, and is intermixed with the fibres of the chondro-glossus.

The *inferior lingual muscle* (musculus longitudinalis inferior) is a rounded fleshy belly which is placed upon the inferior aspect of the tongue. Behind, it lies in the interval between the hyo-glossus and the genio-hyo-glossus, and shows an attachment to the hyoid bone; in front, it is prolonged to the apex of the tongue between the inner border of the stylo-glossus and the genio-hyo-glossus; with the former it is more or less blended.

The *transverse muscular fibres* (musculus transversus linguæ) lie under the lingualis superior, and constitute a thick layer which extends outwards from the lateral face of the septum linguæ, to reach the dorsum and side of the tongue. The fibres of the genio-hyo-glossus ascend through the stratum transversum and break it up into numerous lamellæ (Fig. 161). It is joined by the fibres of the palato-glossus (Henle) (Fig. 160).

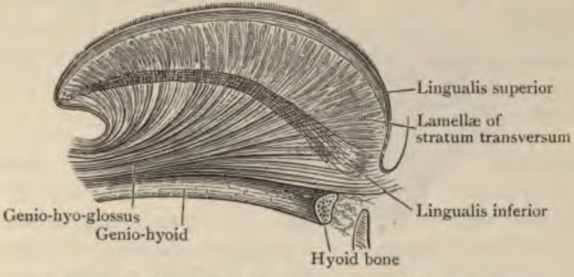

FIG. 161.—Longitudinal section through the Tongue. (From Aeby.)

The *vertical muscular fibres* (musculus verticalis linguæ) extend in a curved direction from the dorsum to the under aspect of the tongue, and decussate with the fibres of the stratum transversum.

Nerves and Vessels of the Tongue.—The nerves of the tongue are—(1) the glosso-pharyngeal; (2) the lingual; (3) the hypoglossal; and (4) a few twigs from the internal laryngeal. These should be traced on the left side of the tongue, where the mucous membrane is still in position.

The *glosso-pharyngeal nerve* has been traced up to the point where it disappears under cover of the hyo-glossus muscle.

Here it divides into two branches. The *smaller* of these extends forwards upon the side of the tongue, and may be traced as far as a point midway between the root and the tip. The *larger* branch turns upwards and is distributed to the mucous membrane which invests the posterior third of the dorsum linguæ. It gives twigs to the circumvallate papillæ, and some fine filaments may be followed to the anterior surface of the epiglottis. The glosso-pharyngeal nerve is the principal nerve of taste.

The *lingual* and *hypoglossal nerves* are described in pages 302 and 303, and their terminal branches should now be traced as far as it is possible to do so.

The *internal laryngeal nerve* gives a few delicate filaments to the glosso-epiglottidean folds and the mucous membrane of the root of the tongue.

The *ranine artery* should be followed to the tip of the tongue, where it forms a small loop of anastomosis with its fellow of the opposite side (p. 305).

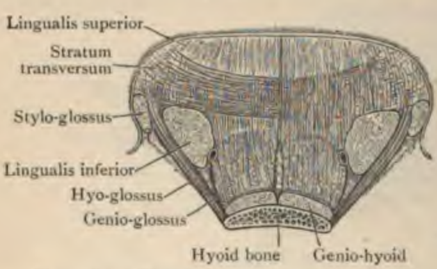

FIG. 162.—Transverse section through the Tongue. (From Aeby.)

Septum Linguæ.—The septum of the tongue can best be seen by making a transverse section through the organ. This will also in a measure demonstrate the transverse and perpendicular muscular fibres. The septum is a mesially placed fibrous partition. It is strongest behind, where it is attached to the hyoid bone.

THE BRAIN.

Directions.—In the first instance the brain should be placed on a dissecting-room platter, with its superior surface uppermost. It is necessary to keep it moist during the whole dissection, by means of a cloth dipped in water. Unless this be done the membranes are apt to become dry, and then they are exceedingly difficult to remove.

General Appearance of the Brain.—When viewed from above, the brain presents an ovoid figure, its broad end being directed backwards. Its greatest transverse diameter is in the neighbourhood of that part which lies between the two parietal eminences of the cranium. The only parts which are visible when the brain is in this position are the two convoluted cerebral hemispheres. These are separated from each other by a deep mesial cleft, called the great longitudinal fissure, which extends from the front to the back of the brain.

The position of the brain should now be reversed. Turn it so that it rests on its superior surface.

The inferior aspect of the brain is usually termed the "base." It presents an uneven and irregular surface, which is more or less accurately adapted to the inequalities on the floor of the cranium. From this point of view some of the main subdivisions of the organ may be recognised. Thus, behind is seen the short cylindrical portion, called the *medulla oblongata* or *bulb*, through which, at the foramen magnum, the brain becomes continuous with the spinal cord. The bulb rests on the under surface of the cerebellum, being received into the vallecula or hollow which intervenes between the two cerebellar hemispheres. The *cerebellum* is a mass of considerable size which lies under the hinder portions of the cerebral hemispheres. It can be easily recognised on account of the closely set, curved and parallel fissures which traverse its surface. Above the medulla, and in direct connexion with it, is a prominent white elevation called the *pons Varolii*. The basilar artery extends upwards in a mesial groove on its surface. Immediately in front of the pons Varolii there is a deep hollow or recess. This is bounded behind by the pons, on either side by the projecting temporal lobes of the cerebrum, and in front by the orbital portions of the frontal lobes of the cerebrum. At the present stage of the examination of the brain, the bottom of this hollow is hidden from view by the arachnoid mater, which stretches over it like a veil; but if the pituitary body has been removed with the brain it will be seen within its limits. Passing out from either side of the fore-part of this recess will be seen the deep Sylvian fissure, which intervenes between the pointed and projecting extremity of the temporal lobe and the frontal lobe

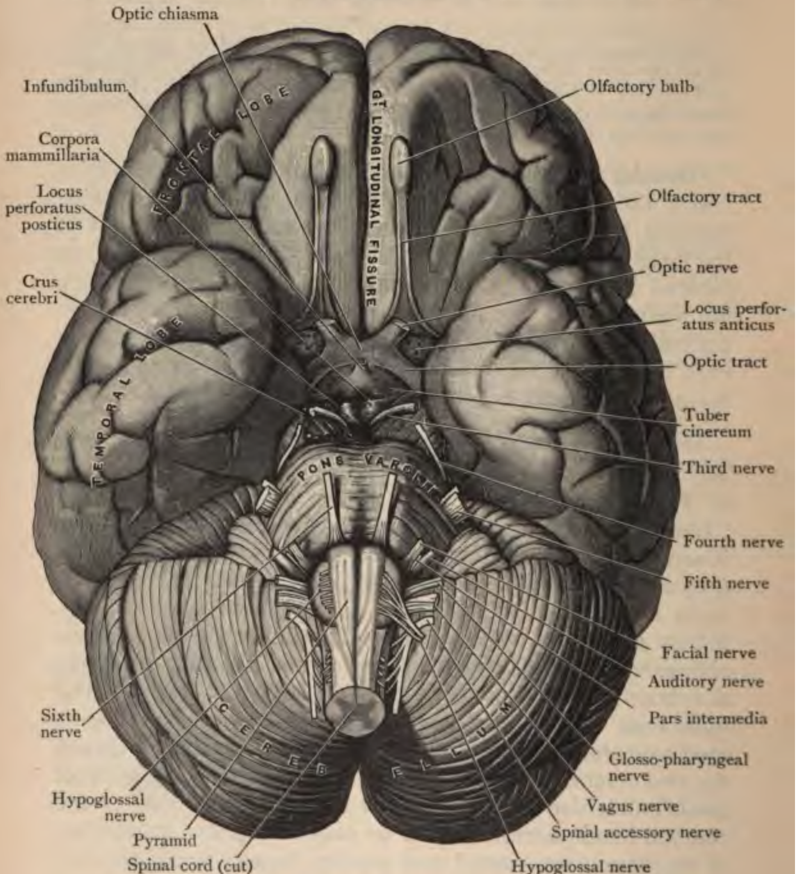
Optic chiasma
Infundibulum
Corpora mammillaria
Locus perforatus posticus
Crus cerebri
FRONTAL LOBE
GT LONGITUDINAL FISSURE
TEMPORAL LOBE
PONS VAROLII
CEREBELLUM
Sixth nerve
Hypoglossal nerve
Pyramid
Spinal cord (cut)
Olfactory bulb
Olfactory tract
Optic nerve
Locus perforatus anticus
Optic tract
Tuber cinereum
Third nerve
Fourth nerve
Fifth nerve
Facial nerve
Auditory nerve
Pars intermedia
Glosso-pharyngeal nerve
Vagus nerve
Spinal accessory nerve
Hypoglossal nerve

FIG. 163.—The Base of the Brain with the Cranial Nerves attached.

of the cerebrum; whilst in the middle line in front the great longitudinal fissure will be observed to separate the frontal portions of the cerebral hemispheres. On either side of the great longitudinal fissure, and separated from it by a narrow gyrus, the *olfactory peduncle* and *bulb* may be recognised.

MEMBRANES AND BLOOD VESSELS OF THE BRAIN.

Arachnoid Mater (arachnoidea encephali).—This forms the intermediate covering of the brain. Placed between the dura mater and the pia mater, it is directly continuous with the arachnoidea of the spinal cord. It is an exceedingly thin and delicate membrane, which can best be seen on the base of the brain, as in this locality it is not so closely applied to the pia mater as elsewhere. Unlike the pia mater, it does not (except in the case of the great longitudinal and the Sylvian fissures) dip into the sulci on the surface of the cerebrum and cerebellum. It bridges over the inequalities on the surface of the brain. It is consequently spread out in the form of a very distinct sheet over the medulla, the pons Varolii, and the hollow on the base of the brain which lies in front of the pons. The cut ends of several of the cranial nerves will be observed projecting through this sheet; whilst in front, immediately to the outer side of the optic nerve, the internal carotid artery may be noticed piercing it.

Subarachnoid Space (cavum subarachnoidale).—The interval between the arachnoidea and the pia mater receives the name of the subarachnoid space. It contains the subarachnoid fluid, and is broken up by a meshwork of fine filaments and trabeculæ, which connects the two bounding membranes (viz., the arachnoidea and the pia mater) in the most intimate manner, and forms a delicate sponge-like interlacement between them. Where the arachnoidea passes over the summit of a cerebral convolution, and is consequently closely applied to the subjacent pia mater, the meshwork is so close and the trabeculæ so short that the two membranes cannot be separated from each other. To the dissector they appear to form a single lamina. In the intervals between the rounded margins of adjacent convolutions, distinct angular spaces exist between the arachnoidea and the pia mater. In these the subarachnoid tissue can be studied, and it will be seen that by these intervals on the surface of the cerebrum, numerous communicating channels are formed which serve for the free passage of the subarachnoid fluid from one part of the brain to another. The larger branches of the arteries and veins of the brain traverse the subarachnoid space; their walls are directly connected with the subarachnoid trabeculæ, and are bathed by the subarachnoid fluid.

Cisternæ Subarachnoidales. — In certain situations the arachnoidea is separated from the pia mater by intervals of considerable depth and extent. These expansions of the subarachnoid space are termed cisternæ subarachnoidales. In these the subarachnoid tissue is greatly reduced. There is no longer a close meshwork; the trabeculæ connecting the two bounding membranes take the form of long filamentous intersecting threads, which traverse the spaces. A beautiful demonstration of these may be obtained by dividing in the mesial plane, with the scissors, the sheet of arachnoidea which is spread over the medulla and pons, and turning the two pieces gently outwards.

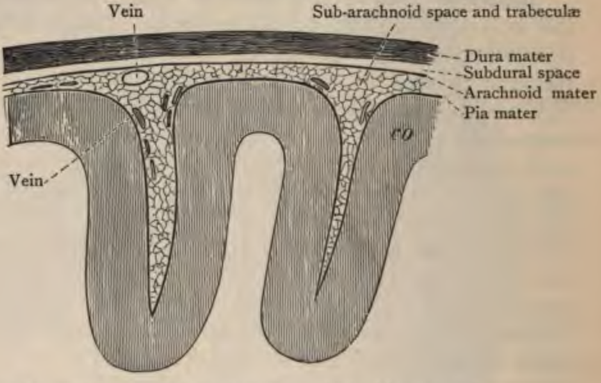

FIG. 164.—Diagrammatic section through the Meninges of the Brain. (Schwalbe.)

co. Grey matter of cerebral convolutions.

Certain of the cisternæ require special mention. The largest and most conspicuous is called the *cisterna magna.* It is a direct continuation of the *posterior* part of the subarachnoid space of the spinal cord upwards into the hinder part of the cranium. It is formed by the arachnoid membrane bridging over the wide interval between the back part of the under surface of the cerebellum and the medulla oblongata.

The *cisterna pontis* is the name given to another of these recesses. It is the continuation upwards on the floor of the cranium of the anterior part of the subarachnoid space of the cord. In the region of the medulla it is continuous on either side with the cisterna magna, so that this subdivision of the brain is completely surrounded by a wide subarachnoid space. Within the cisterna pontis are the vertebral and basilar arteries.

In front of the pons Varolii the arachnoid membrane bridges across between the projecting temporal lobes, and covers in the deep hollow in this region of the base of the brain. This space is called the *cisterna basalis*, and within it are placed the large arteries which take part in the formation of the circle of Willis. Leading out from the cisterna basalis there are certain wide subarachnoid channels. Two of these are prolonged into the Sylvian fissures, and in these are accommodated the middle cerebral arteries and some of their branches. In front the basal cistern passes into a space in front of the optic chiasma, and from this it is continued into the great longitudinal fissure above the corpus callosum. In this subarachnoid passage are lodged the anterior cerebral arteries.

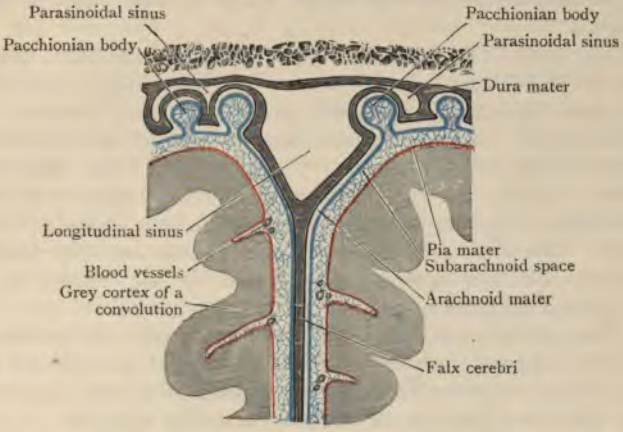

FIG. 165.—Diagram of a coronal section through the middle portion of the cranial vault and subjacent brain to show the membranes of the brain and the Pacchionian bodies.

All the subarachnoid cisterns communicate in the freest manner with each other, and also with the narrow intervals on the surface of the cerebrum. The subarachnoid space does not communicate in any way with the subdural space. In certain localities, however, it communicates with the ventricular system of the brain. Three such apertures are described in connexion with the fourth ventricle, whilst another slit is said to lead from the cisterna basalis into the lower end of the descending horn of the lateral ventricle.

Pacchionian Bodies.—The connexion of the Pacchionian bodies with the arachnoid mater has already been referred to (p. 115).

Pia Mater Encephali.—The pia mater forms the immediate investment of the brain. It is finer and more delicate than the corresponding membrane of the spinal cord, and it follows closely all the inequalities on the surface of the brain. Thus, in the case of the cerebrum, it dips down so as to line both sides of every sulcus and form a fold within it. On the cerebellum the relation is not so intimate; it is only the larger fissures of the cerebellum which contain folds of pia mater.

The larger blood vessels of the brain, as we have noted, run in the subarachnoid space. The finer twigs enter the pia mater and ramify in it before proceeding into the substance of the brain. As they enter they carry with them sheaths derived from the pia mater. Consequently, if the dissector raises a portion of this membrane from the surface of the cerebrum, a number of fine processes will be seen to be withdrawn from the cerebral substance. These are the blood-vessels, and they give the deep surface of the membrane a rough and flocculent appearance.

The pia mater is not confined to the exterior of the brain. A fold is carried into its interior. This will be exposed in the dissection of the brain, and described under the name of the velum interpositum or the tela choroidea superior.

Dissection.—The blood vessels of the brain should now be followed out as far as it is possible to do so without laceration of the brain substance. Begin by stripping the arachnoidea from the base of the brain. This will bring into view the main trunks. In describing the vessels of the brain it is unfortunately necessary to speak of many parts which have not yet come under the notice of the dissector.

Arteries which supply Blood to the Brain.—Four main arterial trunks carry blood into the cranium for the supply of the brain—viz., the two internal carotid arteries and the two vertebral arteries. The vertebral arteries enter through the foramen magnum, whilst the internal carotid arteries gain admittance through the carotid canals. These vessels have been divided in the removal of the brain. The cut end of the internal carotid will be seen on the base of the brain immediately to the outer side of the optic nerve; the vertebral lies on the side of the medulla oblongata. A very remarkable and complete anastomosis takes place on the base of the brain by the inosculation of branches which spring from the carotid and vertebral arterial systems. This is termed the circle of Willis. The branches which take part in this anastomosis are placed in that large expansion of the subarachnoid space which is termed the cisterna basalis.

Two systems of branches, both going to the cerebrum, but differing greatly in their mode of distribution, proceed from the vessels forming the circle of Willis. One system consists of very numerous slender twigs, which, as a rule, come off in groups in certain localities, and at once pierce the substance of the cerebrum so as to gain its interior. These are the *central* or *basal branches.* The other system is composed of branches which ramify over the surface of the cerebrum, and are termed the *cortical branches.* The central parts of the brain, including the basal ganglia, receive their blood-supply from the basal system, and the vessels which constitute this group do not anastomose with each other. The cortical vessels supply the cerebral cortex, and the finer branches which ramify in the pia mater anastomose with each other. It so happens, therefore, that neighbouring vascular districts of the cerebral cortex are not sharply cut off from each other.

Vertebral Artery (arteria vertebralis). — The vertebral artery enters the subarachnoid space in the upper part of the vertebral canal by piercing the dura mater and the arachnoid mater. Gaining the interior of the cranium through the foramen magnum, it is continued upwards on the side of the medulla oblongata. Soon it inclines forwards towards the front of the medulla, and, meeting its fellow of the opposite side in the mesial plane, it unites with it at the lower border of the pons Varolii to form the basilar artery.

During this part of its course the vertebral artery gives off the following branches :—

1. Posterior meningeal.
2. Posterior spinal.
3. Posterior inferior cerebellar.
4. Anterior spinal.
5. Bulbar.

The *posterior meningeal branch* (ramus meningeus) springs from the vertebral artery before it pierces the dura mater, and is distributed in the posterior cranial fossa.

The *posterior spinal* (arteria spinalis posterior) is the first branch that is given off after the vertebral artery pierces the dura mater. It passes downwards on the spinal cord in front of the posterior nerve-roots (p. 170).

The *posterior inferior cerebellar* (arteria cerebelli inferior posterior) is the largest branch of the vertebral artery, and it takes origin immediately above the posterior spinal artery. It pursues a tortuous course backwards on the side of the upper part of the medulla, between the nerve-roots of the hypoglossal, and then between the roots of the vagus. Finally, turning round the restiform body, it gains the vallecula of the cerebellum, where it ends by dividing into two terminal branches. Of these, one turns backwards in the sulcus, between the inferior vermiform process and the lateral hemisphere of the cerebellum, whilst the other ramifies on the posterior part of the inferior surface of the corresponding cerebellar hemisphere.

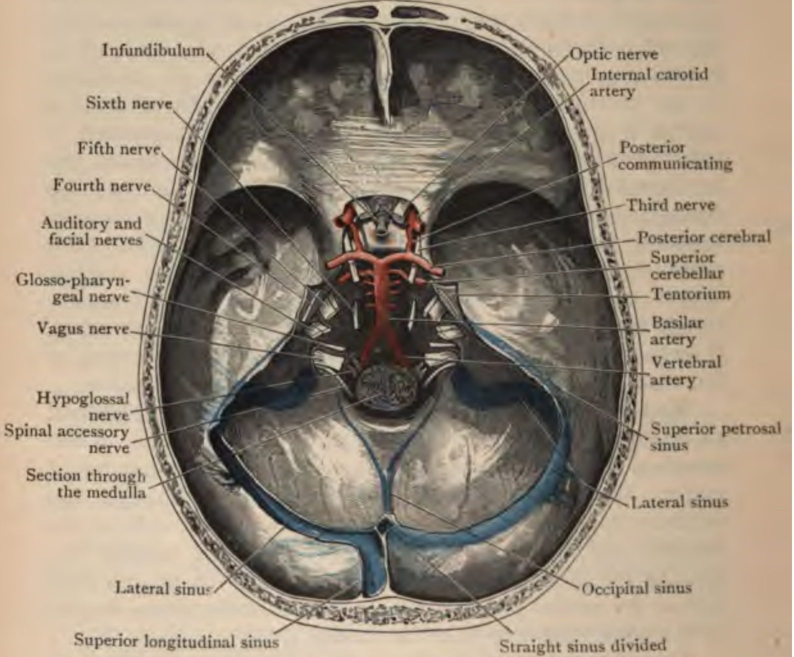
Infundibulum
Sixth nerve
Fifth nerve
Fourth nerve
Auditory and facial nerves
Glosso-pharyngeal nerve
Vagus nerve
Hypoglossal nerve
Spinal accessory nerve
Section through the medulla
Lateral sinus
Superior longitudinal sinus
Optic nerve
Internal carotid artery
Posterior communicating
Third nerve
Posterior cerebral
Superior cerebellar
Tentorium
Basilar artery
Vertebral artery
Superior petrosal sinus
Lateral sinus
Occipital sinus
Straight sinus divided

FIG. 166.—Floor of the Cranium after the removal of the Brain and the Tentorium Cerebelli. The blood vessels forming the circle of Willis have been left in place.

The *anterior spinal artery* (arteria spinalis anterior) arises near the lower border of the pons Varolii. It is rare to find the vessels of the two sides of equal size. They converge on the anterior surface of the medulla, and unite to form the commencement of the median vessel which extends downwards on the ventral face of the cord.

The *bulbar arteries* are minute vessels which enter the substance of the medulla, and spring both from the vertebral artery itself and also from its branches.

Basilar Artery (arteria basilaris).—The basilar artery, which is formed by the union of the two vertebral arteries, is a short trunk which extends in the mesial plane from the lower to the upper border of the pons Varolii. At the latter point it ends by dividing into the two posterior cerebral arteries. The basilar artery lies in the middle part of the cisterna pontis, and occupies the median groove on the ventral or anterior surface of the pons Varolii. In front it is supported by the basilar process of the occipital bone and the dorsum sellæ of the sphenoid.

The branches which spring from the basilar artery, for the most part, proceed outwards from either side of the vessel. They are:—

1. Transverse.
2. Internal auditory.
3. Anterior inferior cerebellar.
4. Superior cerebellar.
5. Posterior cerebral.

The *transverse arteries* (rami ad pontem) are numerous slender twigs which run outwards on the surface of the pons and enter its substance. The *auditory artery* (arteria auditiva interna) will be seen amongst these. It follows the auditory nerve into the internal auditory meatus, and is distributed to the internal ear.

The *anterior inferior cerebellar* (arteria cerebelli inferior anterior) inclines outwards and backwards to reach the anterior part of the inferior surface of the cerebellum.

The *superior cerebellar artery* (arteria cerebelli superior) is a large vessel which springs from the basilar close to its termination. It winds outwards and backwards along the upper border of the pons Varolii to reach the upper surface of the cerebellum, upon which it spreads out in a number of large branches which, for the most part, take a backward course.

Posterior Cerebral Artery (arteria cerebri posterior).—Immediately beyond the origin of the two superior cerebellar arteries, the basilar trunk bifurcates into the two posterior cerebral arteries. These diverge from each other, and, curving outwards, they encircle the mesencephalon, and are carried backwards towards the under surface of the splenium of the corpus callosum. In this course the posterior cerebral artery lies deeply in the interval between the corresponding crus cerebri and the hippocampal gyrus, and, finally passing on to the tentorial surface of the cerebral hemisphere, it disappears from view by sinking into the anterior extremity of the calcarine fissure. In this fissure the artery ends by dividing into two terminal branches, viz., the calcarine and the parieto-occipital (Figs. 167 and 168).

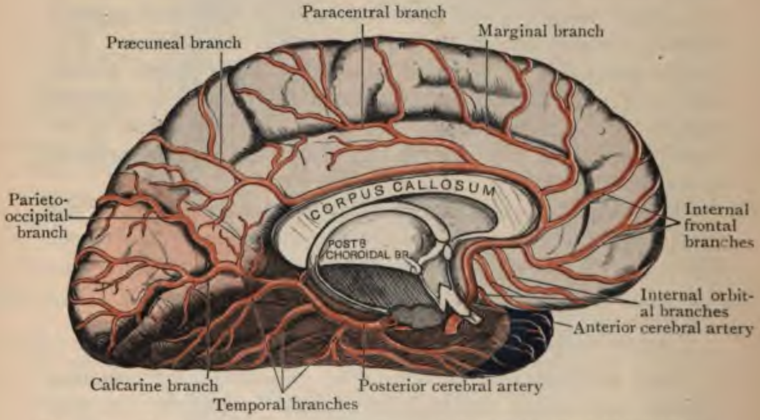
Paracentral branch
Præcuneal branch
Marginal branch
Parieto-occipital branch
CORPUS CALLOSUM
POSTR CHOROIDAL BR.
Internal frontal branches
Internal orbital branches
Anterior cerebral artery
Calcarine branch
Posterior cerebral artery
Temporal branches

FIG. 167.—Internal and Tentorial Surfaces of the left Cerebral Hemisphere. The district supplied by the anterior cerebral artery is tinted *purple*; by the middle cerebral artery, *blue*; and by the posterior cerebral artery, *red*. (Semi-diagrammatic.)

The third or oculo-motor nerve passes forwards in the interval between the posterior cerebral and the superior cerebellar arteries, close to the place where they arise from the basilar; and the small fourth or trochlear nerve is related to the posterior cerebral artery as it winds round the crus cerebri.

The following branches spring from the posterior cerebral artery :—

Central or basal	Postero-mesial. Postero-lateral. Posterior choroidal.	Cortical	Temporal. Calcarine. Parieto-occipital.

The *postero-mesial central arteries* arise close to the origin of the parent trunk. They proceed upwards in the interval between the crura cerebri, and, piercing the locus perforatus posticus, they supply the optic thalamus and the inner part of the crus cerebri.

The *postero-lateral central arteries* are a group of small slender twigs which arise on the outer surface of the crus cerebri, and go to the corpora quadrigemina and the optic thalamus.

The *posterior choroidal artery*, somewhat larger, goes to the velum interpositum and the choroid plexus of the lateral ventricle (Figs. 167 and 168).

The *temporal branches*, two or three in number, turn outwards over the hippocampal gyrus, and ramify on the under surface of the temporal lobe of the cerebrum (Figs. 167 and 168).

The *calcarine branch* (arteria occipitalis) follows the calcarine fissure to the occipital pole of the cerebral hemisphere, round which it turns to reach the outer surface of the occipital lobe. It is the chief artery of supply to the cuneus and the lingual convolution, and is therefore specially concerned in the nutrition of the visual centres in the cerebral cortex (Figs. 167 and 168).

The *parieto-occipital artery* is the smaller of the two terminal branches of the posterior cerebral. It runs upwards in the parieto-occipital fissure, and, reaching the upper margin of the cerebrum, it turns round this to reach the outer surface of the occipital lobe. It supplies branches to the cuneus and præcuneus (Fig. 167).

Internal Carotid Artery (arteria carotis interna).—The terminal part of this great vessel lies on the outer side of the optic chiasma, in the angle between the optic nerve and the optic tract. At the anterior perforated spot, close to the commencement of the Sylvian fissure, it ends by dividing into the anterior and middle cerebral arteries (Fig. 168). The *middle cerebral artery* is the larger of the two terminal branches, and, as it enters the Sylvian fissure, it appears to be the continuation of the parent trunk. The *anterior cerebral artery*, on the other hand, proceeds inwards from the internal carotid at almost a right angle. This explains how it is that emboli pass more frequently into the middle cerebral than into the anterior cerebral artery. From the internal carotid artery, after it has emerged from the cavernous sinus (p. 328), the following branches arise:—

1. Ophthalmic (already studied, p. 339).
2. Posterior communicating.
3. Anterior choroidal.
4. Middle cerebral.
5. Anterior cerebral.

The *posterior communicating artery* (arteria communicans posterior) is as a rule a slender branch which proceeds backwards to join the posterior cerebral between its postero-mesial and postero-lateral groups of basal twigs (Figs. 168 and 170).

The *anterior choroidal artery* (arteria choroidea) enters the descending cornu of the lateral ventricle, and passes into the choroid plexus in that cavity (Fig. 168).

Anterior Cerebral Artery (arteria cerebri anterior).—The anterior cerebral in the first instance takes a horizontal course inwards and forwards (Fig. 168). It passes above the optic chiasma and immediately in front of the lamina cinerea, and finally reaches the hinder end of that part of the great longitudinal fissure which separates the frontal lobes of the cerebrum. Here it lies close to its fellow of the opposite side, and the two vessels are connected by a short transverse trunk of communication, termed the *anterior communicating artery* (arteria communicans anterior). The anterior cerebral artery now enters the great longitudinal fissure, and is carried forwards and upwards on the inner surface of the frontal lobe towards the genu or anterior extremity of the corpus callosum

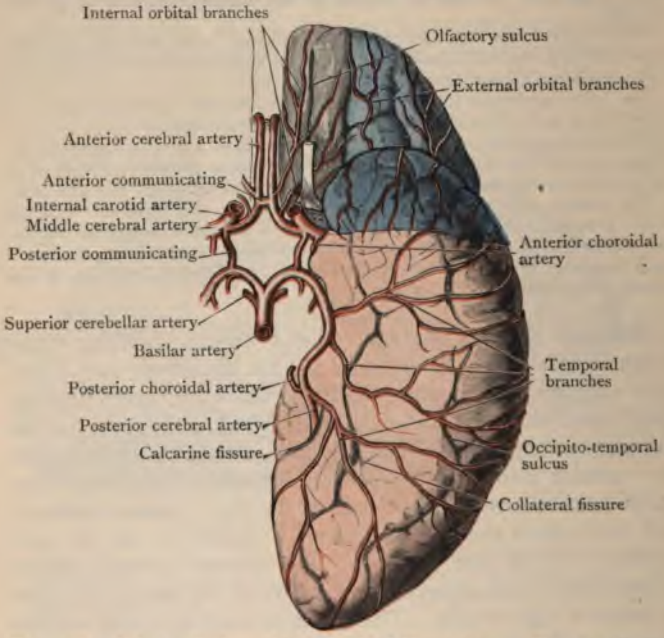
Internal orbital branches
Olfactory sulcus
External orbital branches
Anterior cerebral artery
Anterior communicating
Internal carotid artery
Middle cerebral artery
Posterior communicating
Anterior choroidal artery
Superior cerebellar artery
Basilar artery
Temporal branches
Posterior choroidal artery
Posterior cerebral artery
Calcarine fissure
Occipito-temporal sulcus
Collateral fissure

FIG. 168.—Inferior Surface of the Cerebral Hemisphere. The districts supplied by the three cerebral arteries are tinted differently: posterior cerebral artery, *red*; middle cerebral artery, *blue*; anterior cerebral artery, *purple*.

(Fig. 167). Round this it turns, and it is then continued backwards on the upper surface of the corpus callosum. Very much reduced in size, it gives off its terminal branch (termed the artery of the corpus callosum), which may be traced as far as the splenium or posterior end of the corpus callosum.

Numerous branches proceed from the anterior cerebral artery:—

Basal or central	Antero-mesial.
Cortical .	Inferior internal frontal (or internal orbital). Anterior internal frontal. Middle internal frontal (or paracentral). Posterior internal frontal (or præcuneal).

The *antero-mesial group* of arteries pierce the base of the brain in front of the optic chiasma. They supply the rostrum of the corpus callosum, the lamina cinerea, and the septum lucidum.

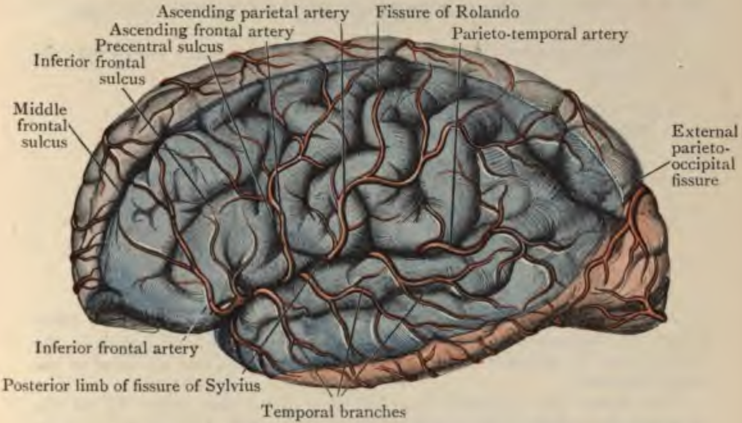
Ascending parietal artery
Fissure of Rolando
Ascending frontal artery
Parieto-temporal artery
Precentral sulcus
Inferior frontal sulcus
Middle frontal sulcus
External parieto-occipital fissure
Inferior frontal artery
Posterior limb of fissure of Sylvius
Temporal branches

FIG. 169.—Outer Surface of the Cerebral Hemisphere. The districts supplied by the three cerebral arteries are tinted differently: anterior cerebral, *purple*; middle cerebral, *blue*; posterior cerebral, *red*. (Semi-diagrammatic.)

The *inferior internal frontal branches* (internal orbital) are two or three in number, and turn round the margin of the great longitudinal fissure to reach the inner part of the orbital surface of the frontal lobe. They supply the gyrus rectus, the olfactory peduncle and bulb, and the internal orbital convolution (Figs. 167 and 168).

The *anterior internal frontal artery* ramifies upon the fore-part of the inner surface of the frontal lobe, and its terminal twigs turn round the upper margin of the cerebral hemisphere, and supply the outer surface of the frontal lobe as far down as the sulcus frontalis medius (Fig. 169).

The *middle internal frontal artery* (paracentral) ramifies on the inner surface of the frontal lobe behind the preceding branch. Its terminal part passes over the paracentral convolution, and reaches the adjacent portion of the outer surface of the cerebral hemisphere (Fig. 169).

The *posterior internal frontal artery* (præcuneal) ramifies on the inner surface of the præcuneus, and its terminal twigs turn round the upper margin of the cerebral hemisphere to gain its outer surface.

Middle Cerebral Artery (arteria cerebri media).—The middle cerebral artery passes outwards and upwards in the Sylvian fissure, and soon breaks up into a number of large terminal branches, which spread out on the surface of the island of Reil. Before the posterior limb of the Sylvian fissure is opened up so as to expose the island of Reil, these branches are observed streaming out from between its two lips (Fig. 169). They then diverge so as to supply a wide area of cortex on the outer surface of the cerebral hemisphere.

The branches which spring from the middle cerebral artery may be classified thus :—

Central or basal branches.	Antero-lateral.	
Cortical branches.	Frontal	External orbital. External inferior frontal. Ascending frontal.
	Parietal	Ascending parietal.
	Parieto-temporal.	
	Temporal.	

The antero-lateral group of basal arteries are very numerous. They pierce the anterior perforated spot and supply the lenticular nucleus, the internal and the external capsule, the caudate nucleus, and a portion of the optic thalamus.

The *frontal* and *parietal branches* turn round the upper lip of the posterior limb of the Sylvian fissure and ascend on the outer surface of the cerebrum. The *frontal branches* are : (1) an *external orbital* to the outer part of the orbital surface of the frontal lobe ; (2) an *inferior external frontal* to the inferior frontal convolution ; (3) an *ascending frontal* which runs upwards in relation to the ascending frontal convolution.

The *ascending parietal branch* extends in an upward and backward direction in relation to the ascending parietal convolution, and its terminal twigs supply the greater part of the cortex of the superior parietal convolution.

The *parieto-temporal branch* is a very large artery which issues from the hinder part of the posterior limb of the fissure of Sylvius and sends branches upwards to the inferior parietal convolution, and others which incline downwards over the hinder part of the temporal lobe. Its twigs, as a rule, do not encroach upon the outer surface of the occipital lobe.

The *temporal branches*, two or three in number, issue from the posterior limb of the Sylvian fissure, and turning downwards and backwards over its lower lip (*i.e.*, the first temporal convolution), they ramify upon the *outer* surface of the temporal lobe.

Circle of Willis (circulus arteriosus Willisii).—This remarkable anastomosis is placed on the base of the brain in the deep hollow in front of the pons Varolii. It takes the form of a heptagonal or hexagonal ring, and the vessels which compose it lie in the large basal subarachnoid space. In front it is closed by the anterior communicating artery which links together the two anterior cerebral arteries. On either side is the posterior communicating artery connecting the internal carotid (from which the anterior cerebral springs) with the posterior cerebral. Behind, the arterial ring is completed by the bifurcation of the basilar artery into the two posterior cerebral vessels (Fig. 170). As a rule the circle of Willis is not symmetrical. The right posterior communicating artery is almost invariably larger than its fellow of the opposite side.

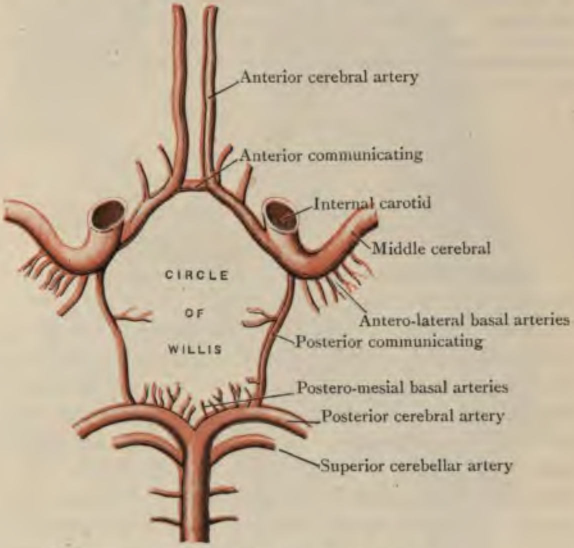
Anterior cerebral artery
Anterior communicating
Internal carotid
Middle cerebral
CIRCLE
OF
WILLIS
Antero-lateral basal arteries
Posterior communicating
Postero-mesial basal arteries
Posterior cerebral artery
Superior cerebellar artery

FIG. 170.—Diagram of the Circle of Willis.

Dissection.—The brain being placed with its base uppermost, the dissector should proceed to remove the blood vessels and membranes from its surface. This must be done with the forceps and a pair of scissors. It is a dissection which requires very delicate manipulation, because the cranial nerves at their points of attachment to the brain are so intimately connected with the pia mater that any undue traction applied to the membranes will tear the nerves away. Indeed, in the case of the medulla oblongata, the dissector is advised to leave the pia mater in position until the nerve roots have been studied. The relation of the pia mater to the fourth ventricle likewise renders this desirable. In so far as the other nerves are concerned, the pia mater may be divided carefully around their roots with the scissors.

In removing the arachnoidea and pia mater from the outer surface of the cerebrum, it is well to raise it in the first instance from the margins of the hemisphere, and then work towards the fissure of Sylvius. By so doing, the membranes and vessels within this great fissure and in relation to the island of Reil can be withdrawn without damage to the brain substance. Of course, at the present stage, the membranes cannot be removed from every part of the brain; but as the dissection proceeds, opportunities for completing the process will arise.

BASE OF BRAIN.

Interpeduncular Space.—When the membranes are removed from the base of the brain, the *crura cerebri*, two large rope-like strands, will be seen issuing from the upper aspect of the pons Varolii. Placed close together as they emerge from the pons, they diverge as they proceed upwards and forwards, and finally each crus disappears into the corresponding side of the cerebrum. Turning round the outer aspect of each crus where it passes into the cerebrum will be seen a flattened band, called the *optic tract*. These bands converge as they pass forwards, and are finally joined together by a short transverse commissural portion, termed the *optic chiasma*. This chiasma is placed below the hinder end of that portion of the great longitudinal fissure which intervenes between the frontal lobes of the cerebrum. The *optic nerve* is continued forwards and outwards from the chiasma and the tract.

The crura cerebri, the optic tracts, and the optic chiasma enclose a deep rhomboidal or lozenge-shaped interval on the base of the brain, which is termed the *interpeduncular space*. Within the limits of this area the following parts may be seen as we pass from behind forwards:—(1) the locus perforatus posticus; (2) the corpora mammillaria; (3) the tuber cinereum, attached to which is the infundibulum of the pituitary body. These structures form the floor of the third ventricle of the brain.

The *oculo-motor nerves* issue from the brain within the interpeduncular space. Each nerve emerges from the inner side of the corresponding crus cerebri.

Locus Perforatus Posticus.—At its posterior angle, immediately in front of the pons Varolii, the interpeduncular space is very deep, and is floored by a layer of grey matter which is perforated by numerous small apertures. This is the *locus perforatus posticus*. From the apertures which are

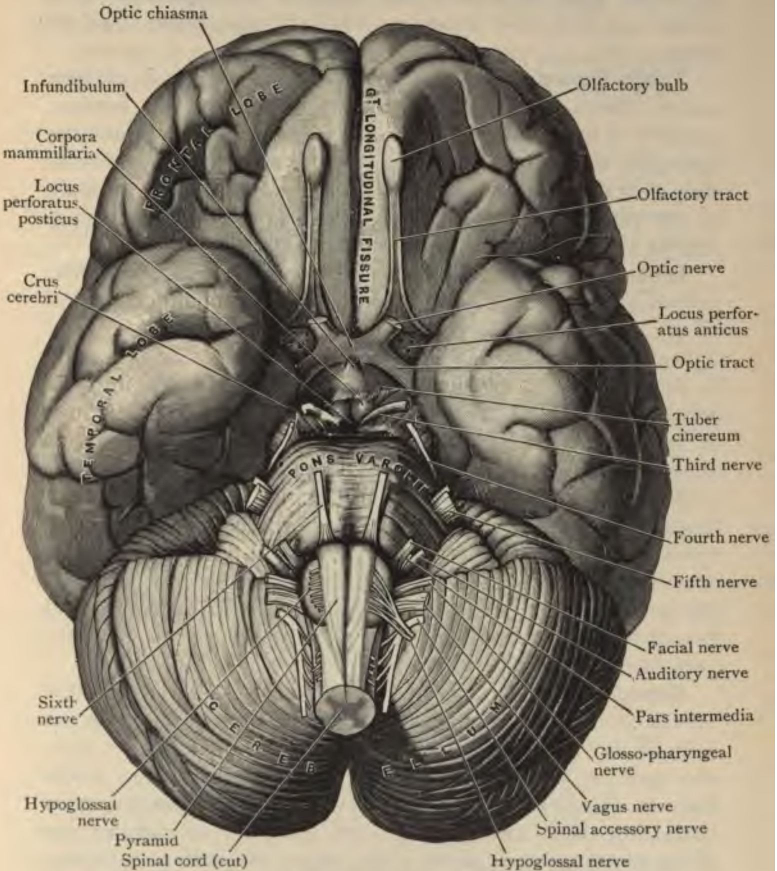
Optic chiasma
Infundibulum
Corpora mammillaria
Locus perforatus posticus
Crus cerebri
Sixth nerve
Hypoglossal nerve
Pyramid
Spinal cord (cut)
Olfactory bulb
Olfactory tract
Optic nerve
Locus perforatus anticus
Optic tract
Tuber cinereum
Third nerve
Fourth nerve
Fifth nerve
Facial nerve
Auditory nerve
Pars intermedia
Glosso-pharyngeal nerve
Vagus nerve
Spinal accessory nerve
Hypoglossal nerve
FRONTAL LOBE
GT. LONGITUDINAL FISSURE
TEMPORAL LOBE
PONS VAROLII
CEREBELLUM

FIG. 171.—The Base of the Brain with the Cranial Nerves attached.

dotted over its surface the postero-mesial basal branches of the posterior cerebral artery have been withdrawn.

Corpora Mammillaria.—These are two small white pea-like eminences placed side by side in front of the locus perforatus posticus. At a later stage of the dissection their connexion with the anterior pillars of the fornix will be brought out.

Tuber Cinereum.—This is a slightly raised field of grey matter which occupies the interval between the anterior portions of the optic tracts in front of the corpora mammillaria. Springing from the fore-part of the tuber cinereum, immediately behind the optic chiasma, is the infundibulum or stalk of the pituitary body. In the removal of the brain its connexion with that body has been severed.

Locus Perforatus Anticus.—This is a small triangular district of grey matter on each side, which is bounded behind by the uncinate extremity of the hippocampal gyrus, in front by the diverging roots of the olfactory peduncle, and internally by the optic tract. It leads in an outward direction into the Sylvian fissure, and is perforated by the antero-lateral groups of basal arteries. The grey matter in this area is continuous above with the grey matter of the lenticular nucleus.

Lamina Cinerea.—If the optic chiasma be now gently raised with the forceps, a thin lamina will be noticed passing upwards from it into the great longitudinal fissure, to become connected with the rostrum of the corpus callosum. This is the *lamina cinerea*. It closes the third ventricle in front, and is continuous on either side with the grey matter of the locus perforatus anticus.

Superficial Origins of the Cranial Nerves.—Twelve cranial nerves are enumerated as arising from the brain on either side of the mesial plane. These are the olfactory, or first; the optic, or second; the oculo-motor, or third; the trochlear, or fourth; the trigeminal, or fifth; the abducent, or sixth; the facial, or seventh; the auditory, or eighth; the glosso-pharyngeal, or ninth; the vagus, or tenth; the spinal accessory, or eleventh; and the hypoglossal, or twelfth.

Each of these nerves is said to have a "superficial" and a "deep" origin. By the term "superficial origin" we refer to the point where its fibres enter or leave the brain surface; by the term "deep origin" we indicate the connexions which are established by the fibres of the different nerves with nuclei or clusters of nerve-cells within the substance of the brain. These nuclei are of two kinds: (1) those in connexion with which the afferent or entering nerves end; and (2) those from which the efferent or emerging nerves arise. It is the superficial attachments only which come under our notice at the present time.

No fewer than eight of the cranial nerves have a superficial attachment to the medulla oblongata and the pons Varolii.

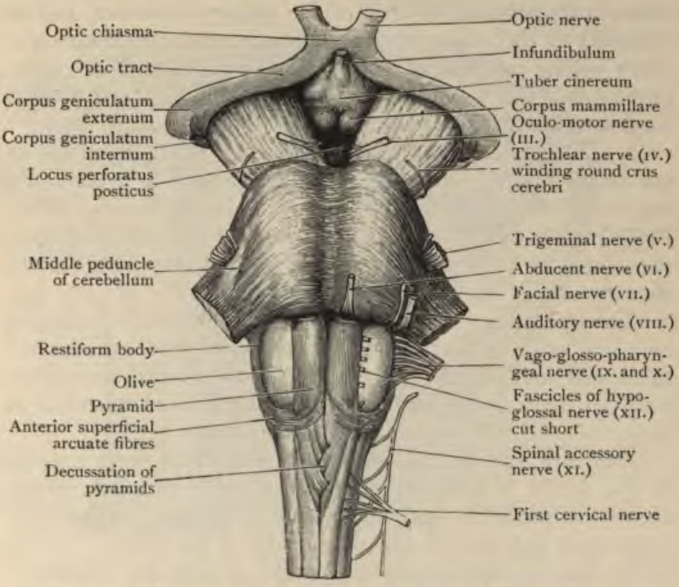
Optic chiasma
Optic tract
Corpus geniculatum externum
Corpus geniculatum internum
Locus perforatus posticus
Middle peduncle of cerebellum
Restiform body
Olive
Pyramid
Anterior superficial arcuate fibres
Decussation of pyramids
Optic nerve
Infundibulum
Tuber cinereum
Corpus mammillare
Oculo-motor nerve (III.)
Trochlear nerve (IV.) winding round crus cerebri
Trigeminal nerve (V.)
Abducent nerve (VI.)
Facial nerve (VII.)
Auditory nerve (VIII.)
Vago-glosso-pharyngeal nerve (IX. and X.)
Fascicles of hypoglossal nerve (XII.) cut short
Spinal accessory nerve (XI.)
First cervical nerve

FIG. 172.—Front view of the Medulla, Pons, and Mesencephalon of a full-time Fœtus.

Hypoglossal Nerve.—Upon the lateral aspect of the medulla, in its upper half, a very conspicuous oval prominence called the olivary eminence may be distinguished. A distinct sulcus or groove, which passes downwards in front of this body, separates it from an elongated strand, termed the pyramid of the medulla. From the bottom of this sulcus a continuous series of nerve fascicles will be seen to issue along the whole length of the medulla. These nerve fascicles belong to two different nerves. Those which issue from the lower part of the groove, below the level of the olivary eminence, belong to the *anterior root* of the *first cervical nerve;* those which emerge from the upper part of the groove, in the interval between the olivary body and the pyramid, form the *hypoglossal nerve.*

Glosso-pharyngeal, Vagus, and Spinal Accessory Nerves.—Behind the olivary eminence, between it and a prominence called the restiform body, there is another continuous row of nerve fascicles connected with the medulla. These extend downwards beyond the level of the olivary eminence, and are attached to the whole length of the medulla in linear order. They belong to three nerves, but it is impossible at present (seeing that the nerve-trunks that they build up are divided) to determine precisely the number of roots which belong to each. From below upwards the nerves which they form are the *spinal accessory*, the *vagus*, and the *glosso-pharyngeal.* The vagus and the glosso-pharyngeal, which issue from the interval between the olivary eminence and the restiform body, have their fascicles of origin much more closely crowded together than the spinal accessory.

The medullary roots of the spinal accessory constitute only one part of that nerve. The *spinal part* springs from the spinal cord, as low down as the sixth cervical nerve, by a series of roots which issue from the lateral column behind the attachment of the ligamentum denticulatum.

Auditory and Facial Nerves.—These issue close together at the lower border of the pons Varolii, and immediately above the restiform body. The *auditory nerve* is the larger of the two, and lies on the outer side of the facial. Its two roots, termed respectively the cochlear and the vestibular, embrace the restiform body.

The *facial nerve* issues from the pons close to its lower border, and immediately to the inner side of the auditory nerve. Between these two nerves a slender filament will be observed. This is the *pars intermedia* of Wrisberg. It joins the facial in the internal auditory meatus.

Abducent Nerve.—This is a small nerve, which emerges from the front of the medulla in the groove between the lower border of the pons Varolii and the outer part of the anterior pyramid.

***Trigeminal* or Fifth Nerve.**—This is the largest of all the cranial nerves. It appears on the side of the pons Varolii, nearer its upper than its lower border, and in a line with the facial and auditory nerves. It consists of two roots—a large sensory root composed of a great number of fasciculi loosely held together, and a small more compact motor root which emerges in front and slightly to the inner side of the point at which the sensory root enters the pons.

Trochlear Nerve.—The superficial origin of the trochlear or fourth nerve cannot be seen at present. It emerges from the valve of Vieussens, on the dorsal aspect of the brain-stem. It is a delicate little nerve which has a long intracranial course, and may be observed winding round the outer side of the crus cerebri, between the cerebrum and cerebellum.

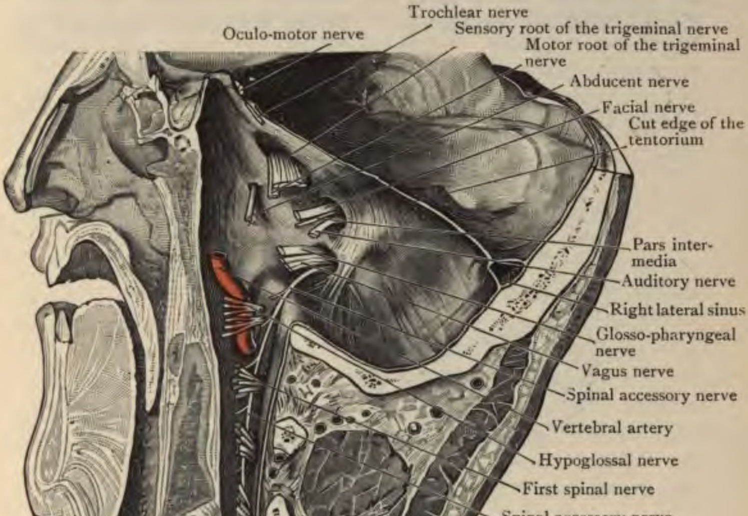
Trochlear nerve
Oculo-motor nerve
Sensory root of the trigeminal nerve
Motor root of the trigeminal nerve
Abducent nerve
Facial nerve
Cut edge of the tentorium
Pars intermedia
Auditory nerve
Right lateral sinus
Glosso-pharyngeal nerve
Vagus nerve
Spinal accessory nerve
Vertebral artery
Hypoglossal nerve
First spinal nerve
Spinal accessory nerve

FIG. 173.—Section through the Head a little to the right of the Mesial Plane. It shows the posterior cranial fossa and the upper part of spinal canal after the removal of the brain and the cord.

Oculo-motor Nerve.—This may be seen within the interpeduncular space. It issues by several fascicles from the sulcus oculomotorius on the inner face of the crus cerebri.

Optic Nerve.—This is a large round nerve which proceeds outwards and forwards from the optic tract and optic chiasma. The origin of the optic tract will be studied at a later stage.

Olfactory Nerves.—These arise from the olfactory bulb or lobe, and enter the nasal chamber through the foramina in the cribriform plate of the ethmoid bone.

General Connexions of the Several Parts of the Brain.—Before proceeding to the more particular study of the different parts of the brain, it is well that the student should acquire a general conception of the manner in which these are connected with each other. In the posterior cranial fossa, below the tentorium, are placed the medulla oblongata, the pons Varolii, and the cerebellum. These structures surround a cavity which is called the fourth ventricle of the brain, and all stand in intimate connexion with each other. The medulla oblongata is for the most part carried upwards into the pons Varolii, but at the same time two large strands on its posterior or dorsal aspect, termed the restiform bodies, are prolonged into the cerebellum, and constitute its *inferior peduncles*, or the bonds of union between the medulla and the cerebellum (Fig. 174, *d*). The transverse fibres of the pons Varolii are gathered together on either side in the form of a large rope-like strand. This disappears into the corresponding hemisphere of the cerebellum, and constitutes its *middle peduncle* (Fig. 174, *c*).

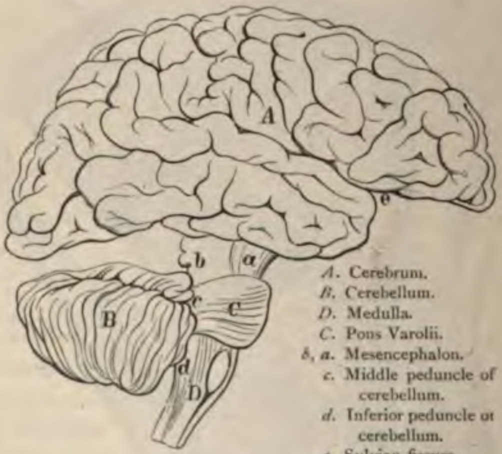
A
e
b
a
B
c
C
d
D
A. Cerebrum.
B. Cerebellum.
D. Medulla.
C. Pons Varolii.
b, *a*. Mesencephalon.
c. Middle peduncle of cerebellum.
d. Inferior peduncle of cerebellum.
e. Sylvian fissure.

FIG. 174.—Diagrammatic view of the manner in which the several parts of the Brain are connected with each other. (From Schwalbe.)

The great mass of the brain is termed the cerebrum. This occupies the anterior and middle cranial fossæ, and extends backwards into the occipital region above the tentorium and the cerebellum. The greater part of the cerebrum is formed by the cerebral hemispheres, which are separated from each other in the mesial plane by the great longitudinal fissure. At the bottom of this fissure may be seen the *corpus callosum*, a broad commissural band which connects the two cerebral hemispheres with each other. Each hemisphere is hollow—the cavity in its interior being termed the *lateral ventricle* of the brain. Between and below the cerebral hemispheres, and almost completely concealed by them, is the *inter-brain* or the *thalamencephalon*. The principal parts forming this portion of the brain are the two optic thalami, between which is the *third ventricle* of the brain—a deep, narrow cavity occupying the mesial plane. The third ventricle communicates with the lateral ventricles through two small apertures, termed the *foramina of Monro*.

The cerebrum is connected with the parts in the posterior cranial cavity (pons Varolii, cerebellum, and medulla oblongata) by a narrow stalk called the *mid-brain*, or the *mesencephalon*. The mid-brain is built up of the crura cerebri, passing from the pons Varolii to the cerebrum (Fig. 174, *a*), the corpora quadrigemina forming its dorsal part (Fig. 174, *b*), the superior cerebellar peduncles proceeding from the cerebellum to the cerebrum, etc. It is tunnelled by a narrow passage—the *aqueduct of Sylvius*—which extends between the fourth and the third ventricles.

THE CEREBRUM.

Cerebral Hemispheres.—Each cerebral hemisphere presents an external, an internal, and an inferior surface, separated from each other by more or less distinctly marked borders. The *external surface* is convex, and is adapted to the concavity of the cranial vault. The *internal surface* is flat and perpendicular, and is more or less completely separated from the corresponding surface of the opposite side by the falx cerebri, which occupies the great longitudinal fissure. The *inferior surface* is irregular, and is adapted to the anterior and middle cranial fossæ, and also to the upper surface of the tentorium cerebelli. Traversing this surface in a transverse direction, nearer the anterior end of the hemisphere than the posterior end, is the stem of the Sylvian fissure (Fig. 171). This deep cleft divides the inferior surface into a front or *orbital area*, which rests upon the orbital plate of the frontal bone, and is consequently concave from side to side, and a more extensive posterior or *tentorial area*, which lies on the floor of the lateral part of the middle cranial fossa and the upper surface of the tentorium cerebelli. This portion of the inferior surface is arched from before backwards, and looks inwards as well as downwards.

The borders which separate these surfaces from each other are the supero-mesial, the superciliary, the infero-lateral, and the internal occipital. The *supero-mesial border*, convex from before backwards, intervenes between the internal and external surfaces. The *superciliary border* is highly arched, and separates the orbital surface from the external surface. The *infero-lateral border* marks off the tentorial surface from the external surface. The *internal occipital border* is not very distinct, except in cases where the brain has been hardened *in situ*. It extends from the posterior extremity of the hemisphere to the hinder end of the corpus callosum, and intervenes between the mesial and tentorial surfaces.

The most projecting part of the anterior end of the cerebral hemisphere is usually called the *frontal pole*, whilst the most projecting part of the hinder end is termed the *occipital pole*. Again, on the under surface of the hemisphere, the prominent point of cerebral substance, which extends forwards below the Sylvian fissure, receives the name of the *temporal pole*. In a well-hardened brain a broad groove is usually present on the inner aspect of the occipital pole of the right hemisphere. This corresponds to the commencement of the right lateral venous sinus.

Great Longitudinal Fissure (incisura pallii).—This great mesial cleft is occupied by the fold of dura mater termed the falx cerebri. In front and behind, it completely separates the cerebral hemispheres from each other, but in its middle part it is floored by the corpus callosum—the commissural band which passes between the hemispheres and connects them together. The upper surface of the corpus callosum can be displayed by gently drawing asunder the two sides of the incisura longitudinalis.

Dissection.—If two brains are available, the dissector is advised at this stage to separate in one of these the cerebrum from the cerebellum, pons, and medulla, by cutting transversely through the mid brain. The cerebrum may then be split in the mesial plane by placing a long knife in the longitudinal fissure, and dividing with one sweep the various parts which connect the two sides to each other. By this proceeding, the three surfaces of each cerebral hemisphere are exposed, and the gyri and sulci can be fully and satisfactorily studied. If only one brain is at the disposal of the student, he should not make this dissection, but endeavour to follow out the gyri and sulci with the various parts of the brain in position. No doubt he studies the hemisphere in this way at a disadvantage, but as the dissection goes on, opportunities will occur which will enable him to examine those districts of the surface which he can only see imperfectly at present.

Cerebral Gyri and Sulci.—The surface of the cerebral hemispheres is rendered highly irregular by the presence of convolutions or gyri, separated from each other by intervening furrows, termed sulci or fissures. The surface pattern, which is presented by these gyri and sulci, is in its general features the same in all human brains; but when the comparison is pushed into more minute detail, many differences become manifest, not only in the brains of different individuals, but also in the two cerebral hemispheres of one individual.

Of the furrows we have to recognise two varieties, viz., complete and incomplete. The *complete fissures* are few in number, and they consist of inwardly directed folds which involve the whole thickness of the cerebral wall. They consequently show in the interior of the cerebral cavity or lateral ventricle in the form of internal elevations on its wall. In this category we include (1) the dentate or hippocampal fissure; (2) the anterior portion of the calcarine fissure; and (3) a portion of the collateral fissure. The *incomplete sulci* are merely furrows of varying depth which do not produce any effect on the inner surface of the ventricular wall.

General Structure of the Cerebral Hemispheres.—Each cerebral hemisphere is composed of an outside coating of grey matter spread in a continuous and uninterrupted layer over its surface, and an internal core of white matter. The grey coating is termed the *cerebral cortex*, whilst the white internal part is called the *medullary centre*. Each convolution shows a corresponding structure. It has an external covering of grey matter supported upon a core of white medullary matter. But in addition to the grey matter on the outside, there are certain large deposits of grey matter embedded in the substance of each hemisphere in its basal part.

These constitute the corpus striatum, and although to a certain extent isolated from the grey matter on the surface, it will be observed later on that at certain points they are directly continuous with it.

By means of the convolutions and sulci the grey matter on the surface of the hemisphere is enormously increased, without unduly adding to the bulk of the organ, and the vascular pia mater, which dips into every fissure, is increased in extent to a like degree. Opportunity is therefore afforded to the cortical vessels of breaking up into twigs of exceeding fineness before entering the substance of the hemisphere. The distribution of the blood to the grey cortex is in this way *equalised* and rendered uniform.

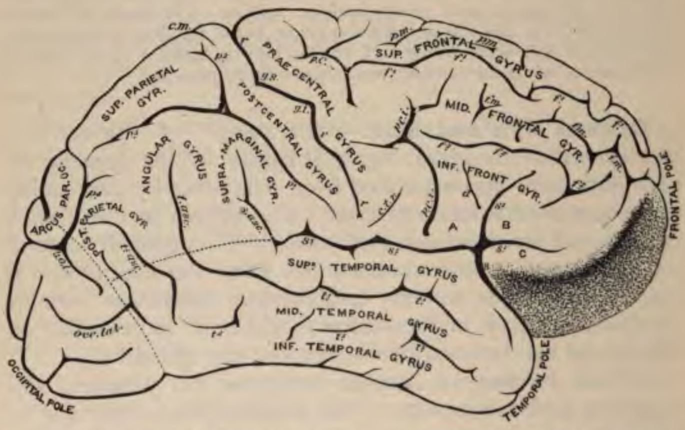
c.m.
PRAECENTRAL GYRUS
POSTCENTRAL GYRUS
SUP. PARIETAL GYR.
SUP. FRONTAL GYRUS
MID. FRONTAL GYR.
INF. FRONT GYR.
ANGULAR GYRUS
SUPRA-MARGINAL GYR.
ARCUS PAR. OC.
POST. PARIETAL GYR.
SUP. TEMPORAL GYRUS
MID. TEMPORAL GYRUS
INF. TEMPORAL GYRUS
p.m.
f.m.
p.c.i.
c.t.r.
g.s.
g.i.
d
A
B
C
t.asc.
s.asc.
occ.lat.
FRONTAL POLE
TEMPORAL POLE
OCCIPITAL POLE

FIG. 175.—Gyri and Sulci on the Outer Surface of the Cerebral Hemisphere.

$f.^1$	Sulcus frontalis superior.
$f.^2$	Sulcus frontalis inferior.
f.m.	Sulcus frontalis medius.
p.m.	Sulcus paramedialis.
A.	Pars basilaris.
B.	Pars triangularis.
C.	Pars orbitalis.
s.	Sylvian fissure.
$s.^1$	Anterior horizontal limb (Sylvian fissure).
$s.^2$	Ascending limb (Sylvian fissure).
$s.^3$	Posterior horizontal limb (Sylvian fissure).
p.c.i.	Inferior præcentral sulcus.
p c.s.	Superior præcentral sulcus.
r.	Fissure of Rolando.
g.s.	Superior genu.
g.i.	Inferior genu.
d.	Sulcus diagonalis.
$t.^1$	Superior temporal sulcus (parallel).
$t.^2$	Inferior temporal sulcus.
$p.^1$	Inferior post-central sulcus.
$p.^2$	Superior post-central sulcus.
$p.^3$	Ramus horizontalis.
$p.^4$	Ramus occipitalis.
s.o.t.	Transverse occipital sulcus.
c.m.	Calloso-marginal sulcus.
c.t.r.	Inferior transverse furrow.

Cerebral Lobes and Interlobar Fissures.—Certain of the fissures which traverse the surface of the cerebrum are arbitrarily chosen for the purpose of subdividing the surface into districts, termed lobes. These fissures, which receive the name of *interlobar*, are the following—(1) the fissure of Sylvius; (2) the fissure of Rolando; (3) the parieto-occipital; (4) the calloso-marginal; (5) the collateral; and (6) the limiting sulcus of Reil.

The lobes which are mapped out by these fissures are—(1) the frontal; (2) the parietal; (3) the occipital; (4) the temporal; (5) the central, or island of Reil; (6) the falciform or limbic. To these may be added a seventh lobe, in no way related to the interlobar fissures, viz., the olfactory lobe.

Fissure of Sylvius.—This is the most conspicuous fissure on the surface of the cerebrum. It is composed of a short main stem, from the outer extremity of which three branches radiate. The *stem* of the Sylvian fissure is placed on the inferior surface of the cerebrum (Fig. 171). It begins at the locus perforatus anticus in a deep depression called the *vallecula Sylvii*. From this it passes horizontally outwards, forming a deep cleft between the temporal pole and the orbital surface of the frontal lobe. Appearing on the outer surface of the cerebrum, the Sylvian fissure immediately divides into three radiating branches. These are—(1) the ramus horizontalis posterior; (2) the ramus horizontalis anterior; and (3) the ramus ascendens anterior.

The *posterior horizontal limb* (Fig. 175) is the longest and the most conspicuous of the three. It extends backwards with a slight inclination upwards for a distance of two inches or more between the frontal and parietal lobes which lie above it, and the temporal lobe which is placed below it. Finally, it comes to an end by turning upwards into the parietal lobe in the form of an *ascending terminal piece* (Fig. 175, *s. asc.*).

The *anterior horizontal limb* (Fig. 175) extends horizontally forwards in the frontal lobe for a distance of about three-quarters of an inch immediately above and parallel to the posterior part of the superciliary margin of the hemisphere.

The *ascending limb* (Fig. 175) proceeds upwards with a slight inclination forwards into the lower part of the outer surface of the frontal lobe for a distance of about an inch. In many cases the two anterior limbs spring from a common stem of greater or less length (Fig. 175).

Limiting Sulcus of Reil (sulcus circularis Reilii).—If the lips of the posterior horizontal limb of the Sylvian fissure be now gently but widely pulled asunder, the island of Reil or the central lobe will be seen at the bottom. This is surrounded by a limiting sulcus, of which we recognise three parts, viz., an *upper part* bounding it above, a *lower part* marking it off below, and an *anterior part* limiting it in front. The insula thus mapped out is somewhat triangular in form.

Opercula Insulæ.—The present is a good time to study the manner in which the insula or island of Reil is shut off from the surface of the hemisphere. When the fissure of Sylvius is held widely open, it will be observed that the insula is overlaid by portions of cerebral cortex which appear as if they were undermined. These by the approximation of their margins or lips form the three limbs of the fissure of Sylvius, and are termed the *opercula insulæ.* It will be noticed that the limbs of the Sylvian fissure cut right through between the different opercula, and extend from the surface of the hemisphere to the surface of the island of Reil. The opercula are four in number, and are named—(1) temporal, (2) fronto-parietal, (3) frontal, and (4) orbital. They are easily distinguished.

The *temporal operculum* extends upwards over the insula from the temporal lobe; it forms the lower lip of the posterior horizontal limb of the Sylvian fissure.

The *fronto-parietal operculum* is carried downwards over the insula to meet the temporal operculum. Its margin forms the upper lip of the posterior horizontal limb of the fissure of Sylvius.

The *frontal operculum* (Fig. 175, B) is the small triangular piece of cerebral cortex between the ascending and anterior horizontal limbs of the Sylvian fissure. It is sometimes termed the *pars triangularis.*

The *orbital operculum* (Fig. 175, C) is for the most part on the under surface of the hemisphere. It lies below and to the inner side of the anterior horizontal limb of the fissure of Sylvius, and proceeds backwards from the orbital aspect of the frontal lobe over the fore-part of the insula.

Fissure of Rolando (sulcus centralis).—The fissure of Rolando takes an oblique course across the outer convex surface of the cerebral hemisphere (Fig. 175). Its upper end cuts the supero-mesial border of the hemisphere a short distance behind the mid-point between the frontal and occipital poles, whilst its lower end terminates above the middle of the posterior horizontal limb of the fissure of Sylvius. Its superior extremity, as a rule, turns round the supero-mesial border of the hemisphere, and is then continued backwards for a short distance on its mesial surface (Fig. 176). Although in its general direction the fissure of Rolando is oblique, it is far from being straight. Nearer to its upper than to its lower end it is bent backwards so as to form a bay, within which is accommodated a portion of the cerebral cortex which represents the motor area of the opposite upper limb. The upper and lower limits of this bay are termed the *upper* and *lower genua* of the fissure.

Parieto-occipital Fissure.—A very small part of this fissure appears on the outer face of the cerebral hemisphere (Fig. 175). For the most part it is situated on the internal surface (Fig. 176). It is customary, therefore, to describe an external parieto-occipital and an internal parieto-occipital fissure. At the same time, it must be clearly understood that they are directly continuous with each other around the supero-mesial margin of the hemisphere.

The *external parieto-occipital fissure* cuts the supero-mesial border of the hemisphere in a transverse direction from one and a half to two inches in front of the occipital pole. It is usually not more than half an inch in length, and it is brought to an abrupt termination by an arching convolution which winds round its extremity, and receives the convenient name of *arcus parieto-occipitalis* (Fig. 175).

The *internal parieto-occipital fissure* (Fig. 176) is carried downwards in a nearly vertical direction as a conspicuous and deep cleft, which, by its lower end, runs into the calcarine fissure.

Collateral Fissure (Fig. 176).—The sulcus collateralis is a strongly marked fissure on the tentorial part of the inferior surface of the cerebral hemisphere. It begins near the occipital pole, and extends forwards towards the temporal pole. In its posterior part it is placed below and parallel to the calcarine fissure, whilst in front it is separated from the hippocampal or dentate fissure by the hippocampal convolution, *i.e.*, the innermost convolution on the tentorial surface of the hemisphere (Fig. 176).

In front of the anterior end of the collateral fissure a shallow sulcus will be seen turning round the anterior end of the temporal lobe so as to intervene between the temporal pole and the uncinate or hook-like extremity of the hippocampal gyrus. This is the *incisura temporalis* or *ecto-rhinal fissure*.

Calloso-marginal Fissure (Fig. 176).—This is a strongly marked sulcus on the fore-part of the mesial surface of the hemisphere. It divides the front portion of the mesial surface into an upper marginal and a lower callosal convolution, and forms on this aspect the lower limit of the frontal lobe. Beginning below the fore end of the corpus callosum, close to the locus perforatus anticus, the calloso-marginal fissure curves round the genu of the corpus callosum, and then extends backwards to a point a short distance behind the middle of the supero-mesial surface. It then turns upwards and cuts the supero-mesial margin of the hemisphere immediately behind the upper end of the fissure of Rolando (Fig. 176). The relation presented by the two extremities of these fissures is such that they can both be readily recognised, either when examined on the outer or the mesial aspect of the cerebrum.

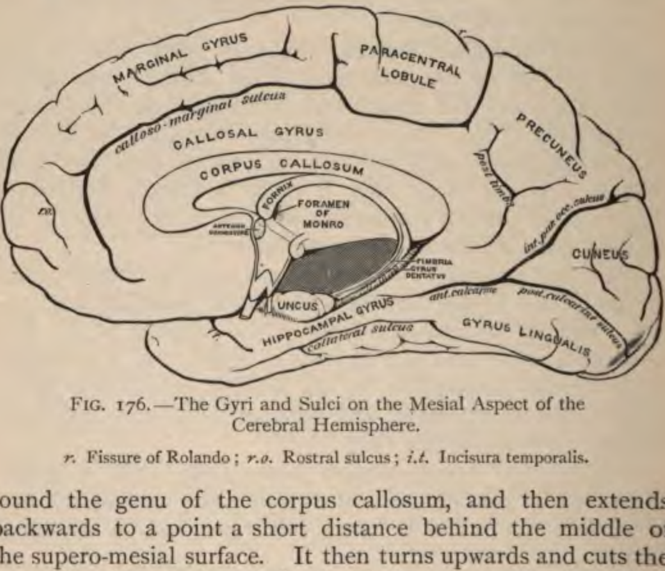
MARGINAL GYRUS
PARACENTRAL LOBULE
r.
calloso-marginal sulcus
CALLOSAL GYRUS
PRECUNEUS
CORPUS CALLOSUM
post. limb
FORNIX
FORAMEN OF MONRO
r.o.
int. par. occ. sulcus
CUNEUS
FIMBRIA
GYRUS DENTATUS
ant. calcarine
post. calcarine sulcus
UNCUS
HIPPOCAMPAL GYRUS
collateral sulcus
GYRUS LINGUALIS
i.t.

FIG. 176.—The Gyri and Sulci on the Mesial Aspect of the Cerebral Hemisphere.

r. Fissure of Rolando; *r.o.* Rostral sulcus; *i.t.* Incisura temporalis.

Boundaries of the Frontal Lobe.—The frontal is the largest of the cerebral lobes. On the outer surface of the hemisphere it is bounded behind by the fissure of Rolando, and below by the posterior horizontal limb of the fissure of Sylvius. On the *mesial face* it is limited by the calloso-marginal fissure, whilst on the inferior surface of the hemisphere the stem of the fissure of Sylvius forms its posterior boundary.

External Surface of the Frontal Lobe.—On the outer surface of the frontal lobe the following sulci and gyri may be recognised:—

Sulci
- Sulcus præcentralis inferior.
- Sulcus præcentralis superior.
- Sulcus paramedialis.
- Sulcus frontalis superior.
- Sulcus frontalis medius.
- Sulcus frontalis inferior.
- Sulcus diagonalis.
- Sulcus fronto-marginalis.

Gyri
- Gyrus frontalis ascendens (or gyrus præcentralis).
- Gyrus frontalis superior
  - Pars superior.
  - Pars inferior.
- Gyrus frontalis medius
  - Pars superior.
  - Pars inferior.
- Gyrus frontalis inferior.
  - Pars basilaris.
  - Pars triangularis.
  - Pars orbitalis.

The *inferior præcentral furrow* (sulcus præcentralis inferior) (Fig. 175) consists of a vertical and a horizontal part, and, when present in a well-marked form, it presents a figure like the letter T or F. The *vertical portion* lies in front of the lower part of the fissure of Rolando, whilst the *horizontal portion* extends obliquely forwards and upwards into the middle frontal convolution.

The *superior præcentral furrow* (sulcus præcentralis superior) (Fig. 175) is a short vertical sulcus which lies at a higher level than the inferior præcentral furrow, in front of the upper part of the fissure of Rolando. It is almost invariably connected with the hinder end of the superior frontal sulcus.

The *ascending frontal convolution* (gyrus centralis anterior) is a long continuous gyrus which is limited in front by the two præcentral furrows, and behind by the fissure of Rolando. It extends obliquely across the hemisphere, from the supero-mesial margin above to the posterior horizontal limb of the Sylvian fissure below (Fig. 175).

The *superior frontal sulcus* (sulcus frontalis superior) (Fig. 175) extends forwards in a more or less horizontal direction from the sulcus præcentralis superior.

The *superior frontal gyrus* (gyrus frontalis superior) (Fig. 175) is the narrow convolution between the supero-mesial border of the hemisphere and the superior frontal sulcus. It takes a horizontal course forwards to the frontal pole.

The *inferior frontal sulcus* (sulcus frontalis inferior) (Fig. 175) occupies a lower level than the superior furrow of the same name. Its hinder end is placed in the angle between the vertical and horizontal parts of the inferior præcentral sulcus, and is not infrequently confluent with one or other of these. It proceeds forwards towards the superciliary margin of the hemisphere, and ends a short distance from this in a terminal bifurcation.

The *middle frontal gyrus* (gyrus frontalis medius) (Fig. 175) is the broad convolution which lies between the superior and inferior frontal furrows.

The *inferior frontal gyrus* (gyrus frontalis inferior) (Fig. 175) is that portion of the outer surface of the frontal lobe which is placed in front of the inferior præcentral sulcus and below the inferior frontal sulcus.

The *sulcus paramedialis* (Fig. 175) is the term applied to a series of short irregular furrows arranged longitudinally, close to the supero-mesial border of the hemisphere. These rudimentary sulci partially subdivide the superior frontal convolution into an upper and lower division, and are of interest in so far that they are best marked in high types of brain.

The *middle frontal sulcus* (sulcus frontalis medius of Eberstaller) (Fig. 175) proceeds horizontally forwards in the fore-part of the middle frontal convolution, so as to divide it into an upper and a lower part (Fig. 175). When it reaches the superciliary margin of the hemisphere it bifurcates, and its terminal branches spread out widely from each other, and together constitute a transverse furrow called the sulcus fronto-marginalis (Wernicke).

Owing to the subdivision of the superior and middle frontal convolutions in the manner indicated, the convolutions in the anterior part of the outer surface of the frontal lobe are arranged in five horizontal tiers.

The *inferior frontal convolution* (gyrus frontalis inferior) possesses a special interest and importance, on account of the localisation within it, on the left side, of the speech-centre. It consists of an *upper non-opercular* and a *lower opercular portion*. The latter is cut up into three parts by the two anterior limbs of the fissure of Sylvius. These are termed the pars basilaris, the pars triangularis, and the pars orbitalis.

The *pars basilaris* (Fig. 175) is that part which lies between the vertical limb of the inferior præcentral sulcus and the ascending limb of the Sylvian fissure. It forms the anterior portion of the fronto-parietal operculum, and it is traversed in an oblique direction by a shallow but constant furrow, termed the *sulcus diagonalis* (Fig. 175).

The *pars triangularis* (Fig. 175) is simply another name for the frontal operculum. It is triangular in form, and lies between the ascending and anterior horizontal limbs of the Sylvian fissure.

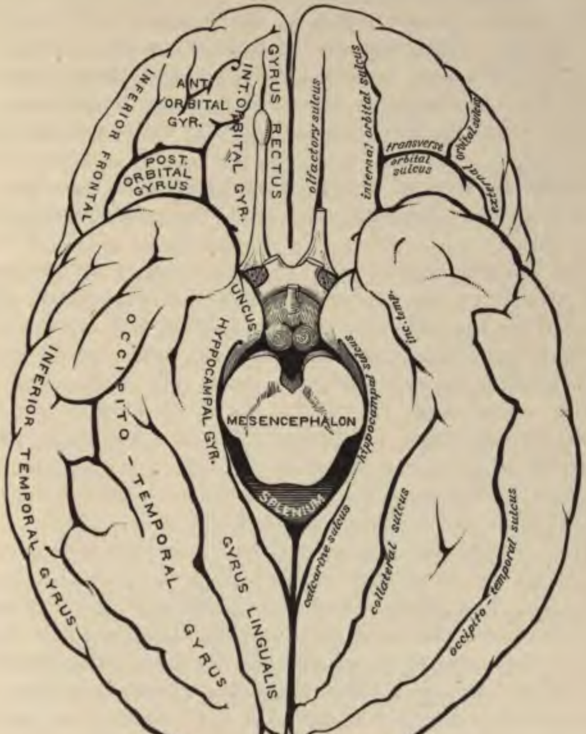
INFERIOR FRONTAL
ANT. ORBITAL GYR.
POST. ORBITAL GYRUS
INT. ORBITAL GYR.
GYRUS RECTUS
olfactory sulcus
internal orbital sulcus
transverse orbital sulcus
external orbital sulcus
UNCUS
HYPPOCAMPAL GYR.
inc. temp.
hippocampal sulcus
MESENCEPHALON
SPLENIUM
INFERIOR TEMPORAL GYRUS
OCCIPITO - TEMPORAL GYRUS
GYRUS LINGUALIS
calcarine sulcus
collateral sulcus
occipito - temporal sulcus

FIG. 177.—Gyri and Sulci on the Tentorial and Orbital Surfaces of the Cerebral Hemispheres.

The *pars orbitalis* (Fig. 175) is placed below the anterior horizontal limb of the fissure of Sylvius.

Mesial Surface of the Frontal Lobe.—On this aspect of the frontal lobe there is an elongated, more or less continuous, convolution called the *gyrus marginalis.* It lies between the supero-mesial border of the hemisphere and the calloso-marginal fissure (Fig. 176). In the fore-part of this gyrus one or two curved sulci are usually present. These are termed the *sulci rostrales* (Fig. 176).

Further, the posterior part of the marginal convolution is more or less completely cut off from the portion which lies in front. This part is called the *paracentral lobule*, and into it the upper end of the fissure of Rolando is prolonged, as it turns over the supero-mesial border of the hemisphere (Fig. 176).

Orbital Surface of the Frontal Lobe.—On this aspect of the frontal lobe there are two sulci—viz., the olfactory and the orbital.

The *olfactory sulcus* (Fig. 177) is a straight furrow which runs parallel to the mesial border of the hemisphere. It is occupied by the olfactory tract and bulb, and it cuts off a narrow strip of the orbital surface close to the mesial border which receives the name of *gyrus rectus* (Fig. 177).

The *orbital sulcus* (tri-radiate sulcus of Turner) is a compound furrow which assumes many different forms. Most frequently it takes the shape of the letter H, and we then recognise three component parts—viz., an external limb, an internal limb, and a transverse limb.

The *external limb* (sulcus orbitalis externus) curves round the orbital part of the inferior frontal gyrus, so as to limit it internally. The *internal limb* (sulcus orbitalis internus) marks off a convolution between itself and the olfactory sulcus which receives the name of *gyrus orbitalis internus.* The *transverse limb* (sulcus orbitalis transversus) takes a curved course with the concavity directed backwards. It divides the district between the external and internal limbs into an anterior part, or *gyrus orbitalis anterior*, and a posterior part, or *gyrus orbitalis posterior.* The latter corresponds with the greater part of the orbital operculum (Fig. 177).

Boundaries of the Parietal Lobe.—The parietal lobe forms a considerable part of the external face of the cerebral hemisphere, and it also appears on the mesial face in the form of the præcuneus or quadrate lobule. *In front*, it is bounded by the fissure of Rolando, which separates it from the frontal lobe. *Below*, it is bounded in its fore-part by the posterior horizontal limb of the Sylvian fissure. Behind the upturned end of this fissure, it is quite continuous inferiorly with the temporal lobe, and an arbitrary line drawn backwards on the surface of the brain in continuation of the horizontal part of the posterior limb of the fissure of Sylvius is taken as its inferior limit (Fig. 175). *Posteriorly*, it is separated from the occipital lobe at the supero-mesial border of the hemisphere by the external parieto-occipital fissure. Below this it is more or less directly continuous with the occipital lobe, and an arbitrary line drawn across the outer surface of the hemisphere from the extremity of the external parieto-occipital fissure to an indentation on the infero-lateral border of the hemisphere, termed the *præoccipital notch*, may be regarded as furnishing a posterior limitation. The præoccipital notch is, as a rule, only visible in brains that have been hardened *in situ*. It is produced by a slight wrinkle or fold of the dura mater on the deep aspect of the parieto-mastoid suture, and in relation to the portion of the lateral venous sinus which lies in this locality. The notch is placed on the infero-lateral border of the hemisphere, about one inch and a half in front of the occipital pole.

Mesial Surface of the Parietal Lobe—Præcuneus.—On the mesial surface of the hemisphere the parietal lobe is represented by the *præcuneus* or *quadrate lobule*. This district, which is somewhat quadrilateral in form, lies between the upturned hinder end of the calloso-marginal fissure and the internal parieto-occipital fissure. Below, it is imperfectly separated from the limbic lobe by a somewhat variable sulcus called the *post-limbic sulcus* (Fig. 176).

External Surface of the Parietal Lobe.—The gyri and sulci on the outer surface of the parietal lobe are the following:—

Gyri
- Ascending parietal or postcentral.
- Superior parietal lobule.
- Inferior parietal lobule.
  - Supra-marginal.
  - Angular.
  - Postparietal.

Sulci
- Intraparietal of Turner.
  - Sulcus postcentralis inferior.
  - Sulcus postcentralis superior.
  - Ramus horizontalis.
  - Ramus occipitalis.
- Upturned ends of—
  - (*a.*) Sylvian.
  - (*b.*) Parallel.
  - (*c.*) Second temporal.

Intraparietal Sulcus of Turner.—This is a composite sulcus built up out of four originally distinct factors. Two of these, termed the sulcus postcentralis inferior and the sulcus postcentralis superior, take a more or less vertical course across the hemisphere, and are most frequently continuous with each other. The other two factors are placed horizontally one behind the other, and they are called the ramus horizontalis and the ramus occipitalis.

The *sulcus postcentralis inferior* (Fig. 175) lies behind the lower part of the fissure of Rolando, whilst the *sulcus postcentralis superior* (Fig. 175) occupies a similar position in relation to the upper part of that fissure. When confluent with each other they form a long continuous furrow, which stretches across the hemisphere behind the fissure of Rolando and parallel to it (Fig. 175).

The *ramus horizontalis* (Fig. 175) is continuous with the upper end of the sulcus postcentralis inferior, and extends backwards, with a slight inclination upwards, between the superior parietal lobule, which lies above it, and the inferior parietal lobule, which lies below it. With the two confluent postcentral sulci it presents a figure like the letter ⊣ placed on its side.

The *ramus occipitalis* (Fig. 175) is a curved sulcus which bounds externally the arcus parieto-occipitalis, or, in other words, the arching convolution which surrounds the external parieto-occipital fissure. Sometimes the ramus occipitalis is linked on to the ramus horizontalis—more frequently it is separate. Its posterior end runs into the occipital lobe, and behind the arcus parieto-occipitalis it bifurcates into two widely-spread-out branches. These form a short transverse fissure in the occipital lobe, termed the *sulcus occipitalis transversus* (Ecker) (Fig. 175).

The upturned ends of the posterior horizontal limb of the fissure of Sylvius (Fig. 175, *s. asc.*), of the parallel or first temporal fissure (Fig. 175, *t.*^{1} *asc.*), and of the second temporal sulcus (Fig. 175, *t.*^{2} *asc.*) extend for a short distance, one behind the other, into the inferior parietal lobule.

Gyri on the External Surface of the Parietal Lobe.—The intraparietal sulcus maps out three districts or areas on the outer surface of the parietal lobe. These are the ascending parietal convolution and the superior and inferior parietal lobules.

The *ascending parietal convolution* or *gyrus centralis posterior* (Fig. 175) is a long gyrus which extends obliquely across the hemisphere from the supero-mesial border above to the posterior limb of the Sylvian fissure below. In front, it is bounded by the fissure of Rolando, and behind by the superior and inferior postcentral furrows.

The *superior parietal lobule* is the area of cerebral cortex which lies between the ramus horizontalis below and the supero-mesial border of the hemisphere above. In front, it is bounded by the superior postcentral sulcus; whilst behind, it is connected with the occipital lobe by the arcus parieto-occipitalis. It is continuous around the supero-mesial border of the hemisphere with the præcuneus.

The *inferior parietal lobule* lies below the ramus horizontalis and the ramus occipitalis, and behind the inferior post-central furrow. It is more or less directly continuous with the occipital lobe behind and the temporal lobe below. From before backwards it presents three arching convolutions, viz., the supra-marginal, the angular, and the post-parietal.

The *supra-marginal convolution* (Fig. 175) is folded round the upturned end of the posterior limb of the fissure of Sylvius, and stands in continuity with the first temporal convolution. The *angular gyrus* (Fig. 175) arches over the upturned end of the parallel or first temporal sulcus, and is continuous with the second temporal convolution. The *post-parietal convolution* (Fig. 175) winds round the upturned end of the second temporal sulcus, and runs into the third temporal gyrus.

Boundaries of the Occipital Lobe.—The occipital lobe forms the hinder pyramidal part of the cerebral hemisphere, and it may be defined as being that portion of the hemisphere which encloses the posterior horn of the lateral ventricle. On the surface it is very imperfectly mapped off from the parietal and temporal lobes which lie in front of it. Being pyramidal in form, it presents three surfaces and an apex or occipital pole. On the mesial aspect of the hemisphere it is separated from the parietal lobe (*i.e.*, the præcuneus) by the internal parieto-occipital fissure. On the tentorial or inferior surface it is not marked off in any way from the temporal lobe and the hippocampal part of the limbic lobe which lie in front of it. It is necessary, therefore, on this aspect, to employ an arbitrary line of demarcation; one which extends from the præoccipital notch on the infero-lateral border of the hemisphere to the isthmus of the limbic lobe (*i.e.*, the narrow part of the limbic lobe immediately below the hinder end of the corpus callosum) will serve the purpose. On the external surface the external parieto-occipital fissure and an arbitrary line from this to the præ-occipital notch may be regarded as separating the occipital from the parietal and temporal lobes.

Mesial Aspect of the Occipital Lobe.—On this surface we find (1) the calcarine fissure; (2) the cuneus; and (3) the gyrus lingualis.

The *calcarine fissure* begins on the occipital pole by a bifurcated extremity which lies in the groove which is formed on this part of the brain by the lateral sinus. From this it pursues a slightly arched course forwards, and ends by cutting into the limbic lobe immediately below the thickened posterior extremity (splenium) of the corpus callosum. The calcarine fissure is joined by the internal parieto-occipital fissure at a point somewhat nearer its anterior than its posterior extremity. Together the two fissures present a ≻-shaped figure.

If the calcarine and internal parieto-occipital fissures be fully opened up, so as to expose the bottom in each case, two well-marked deep or submerged gyri will be displayed (Fig. 178). One of these, the *gyrus cunei*, marks off the parieto-occipital fissure from the calcarine fissure; the other interrupts the calcarine fissure immediately behind its junction with the parieto-occipital. It is called the *anterior cuneo-lingual deep gyrus*, and it divides the calcarine fissure into an anterior and a posterior part. The *anterior calcarine fissure* corresponds very nearly to the stem of the ≻-shaped fissural arrangement. It is very deep, and being a complete fissure, it gives rise to an elevation on the inner wall of the posterior horn of the lateral ventricle, called the calcar avis or the hippocampus minor. The *posterior calcarine fissure* is much shallower.

The *cuneus* (Fig. 176) is the wedge-shaped or triangular district on the mesial aspect of the occipital lobe which lies between the internal parieto-occipital and calcarine fissures.

The *gyrus lingualis* (Fig. 176) is a well-marked convolution between the calcarine fissure above and the posterior part of the collateral fissure below, which stretches forwards from the occipital pole. Anteriorly it becomes very narrow, and joins the hippocampal part of the limbic lobe. It lies partly on the mesial and partly on the tentorial surface of the occipital lobe.

Tentorial Surface of the Occipital Lobe.—On this aspect there is only one convolution, viz., the posterior part of the *occipito-temporal gyrus* (Fig. 177). It proceeds continuously forwards into the temporal lobe on the outer side of the collateral fissure, and it is bounded externally by the *occipito-temporal sulcus*—a furrow which is rarely continuous, but is usually represented by a series of detached pieces.

External Surface of the Occipital Lobe.—There are two well-marked sulci on this face of the occipital lobe—viz., the sulcus occipitalis transversus and the sulcus occipitalis lateralis or sulcus lunatus of Elliot Smith.

The *sulcus occipitalis transversus* (Fig. 175) extends transversely across the upper part of the lobe behind the arcus parieto-occipitalis. It has already been described as the terminal bifurcation of the ramus occipitalis of the intraparietal sulcus.

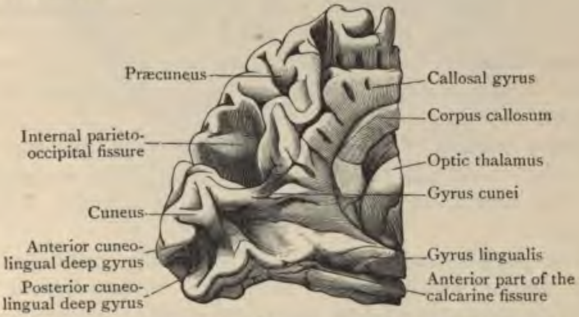
Præcuneus
Callosal gyrus
Corpus callosum
Internal parieto-occipital fissure
Optic thalamus
Gyrus cunei
Cuneus
Anterior cuneo-lingual deep gyrus
Gyrus lingualis
Posterior cuneo-lingual deep gyrus
Anterior part of the calcarine fissure

FIG. 178.—Posterior Part of Inner Surface of the Left Hemisphere. The calcarine and the internal parieto-occipital fissures are widely opened up so as to show the deep gyri within them.

The *sulcus occipitalis lateralis* (Fig. 175) is a short horizontal furrow which divides the outer surface of the lobe into an upper and a lower area of very nearly equal extent. These areas are connected by means of superficial annectant gyri with the parietal and temporal lobes.

Boundaries of the Temporal Lobe.—The temporal lobe lies behind the stem and below the posterior horizontal limb of the fissure of Sylvius. It is somewhat pyramidal in form, and presents an upper, an outer, and a tentorial surface, with a free projecting apex or pole. Above, it is bounded by the posterior horizontal limb of the fissure of Sylvius, together with the artificial line which is drawn backwards from this. On the tentorial surface it is separated from the hippocampal part of the limbic lobe by the collateral fissure ; whilst behind, it is marked off from the occipital lobe by the arbitrary lines already described (p. 475). The apex or temporal pole projects forwards on the under surface of the brain beyond the stem of the Sylvian fissure. It should be noticed that the recurved extremity of the hippocampal part of the limbic lobe (uncus) which lies to the inner side of the temporal pole does not project so far forwards as the latter, and is separated from the pole by the *incisura temporalis* or *ecto-rhinal fissure*.

Upper or Opercular Surface of the Temporal Lobe.—This is the surface of the temporal operculum which is opposed to the island of Reil and the fronto-parietal operculum. The fissure of Sylvius must therefore be widely opened up to expose it. For the most part the surface is smooth, but towards its back part there are a few shallow transverse furrows, called the *sulci of Heschl*, whilst in front, on the deep aspect of the temporal pole, two or three furrows are also evident.

Outer Surface of the Temporal Lobe.—On this aspect of the lobe there are two horizontal sulci, called respectively the first temporal, or parallel, and the second temporal sulcus.

The *parallel sulcus* (Fig. 175) is a long continuous and deep fissure which begins near the temporal pole, and proceeds backwards below the posterior limb of the Sylvian fissure. Its hinder end turns upwards into the parietal lobe, and is surrounded by the angular gyrus.

The *second temporal sulcus* is placed midway between the parallel sulcus and the infero-lateral border of the hemisphere. It is very rare to find it in the form of a continuous cleft. Usually it is broken up into several isolated pieces, placed one behind the other. Its hinder part, which turns upwards into the parietal lobe (Fig. 175), and is surrounded by the post-parietal gyrus, lies close to the artificial line of demarcation between the occipital and parietal lobes.

By the two temporal sulci the outer surface of the temporal lobe is mapped out into three tiers of horizontal convolutions, which are termed the *first*, *second*, and *third temporal gyri* (Fig. 175).

Tentorial Surface of the Temporal Lobe.—On this surface there is one fissure, termed the occipito-temporal sulcus.

The *occipito-temporal sulcus* (Fig. 177) lies to the outer side of the collateral fissure and close to the infero-lateral border of the hemisphere. It runs in an antero-posterior direction, and is not confined to the temporal lobe, but extends backwards towards the occipital pole. It is usually broken up into two or more separate pieces.

The *occipito-temporal convolution* (Fig. 177) is situated between the collateral fissure and the occipito-temporal sulcus.

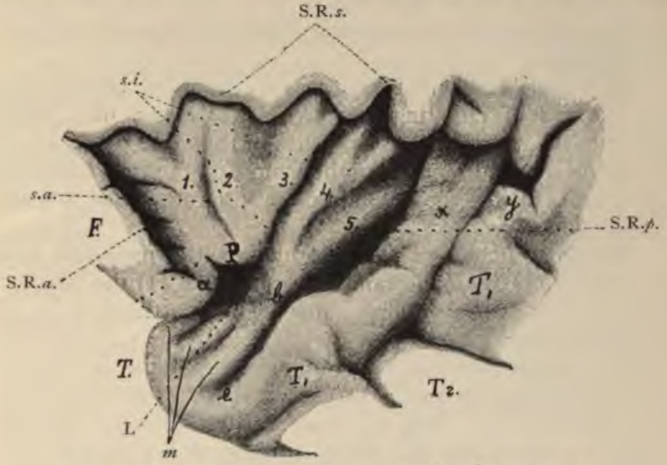

FIG. 179.—Fissures and Gyri on the Surface of the Insula. (Eberstaller.)

1, 2, and 3. Three short gyri on the frontal part of the insula.
4 and 5. Two long gyri on parietal part.
S.R.*a.* Anterior limiting sulcus.
S.R.*s.* Superior limiting sulcus.
S.R.*p.* Inferior limiting sulcus.
L. Limen insulæ.
P. Pole of the insula.

F. Orbital operculum (for the most part removed).
T. Temporal pole.
T_1. First temporal gyrus.
T_2. Second temporal gyrus.
x.y. Gyri of Heschl.
s.i. Sulcus centralis insulæ.
s.a. Sulcus præcentralis insulæ.
m. Gyri on deep surface of temporal pole.

It extends from the occipital pole behind to the temporal pole in front.

The narrow strip of surface on the outer side of the occipito-temporal sulcus is continuous round the infero-lateral margin of the hemisphere with the third temporal convolution on the outer surface of the cerebrum, and may be reckoned as a part of it.

The three temporal convolutions and the occipito-temporal convolution run into each other at the temporal pole.

Island of Reil or Insula.—The insula is a triangular field of cerebral cortex which lies on a deeper plane than the general surface of the hemisphere, and is hidden from view by the four opercula which overlap it (p. 466). It is bounded by a distinct limiting sulcus (sulcus circularis Reilii), which has already been described; and its dependent apical part or pole which looks downwards, is in close relation to the Sylvian vallecula and the anterior perforated spot on the base of the brain.

The insula is divided into several diverging convolutions by a series of radiating sulci. Of the latter, one, which presents the same direction and lies in the same plane as the fissure of Rolando, receives the name of the *sulcus centralis insulæ*. It divides the insula into an anterior *frontal part* and a posterior *parietal portion*.

Olfactory Lobe.—The olfactory lobe is small and rudimentary in the human brain. It comprises (1) the olfactory bulb and tract with the two roots of the latter, and (2) the trigonum olfactorium.

The *olfactory tract* is a narrow white prismatic band, which expands anteriorly into a swollen bulbous extremity termed the *olfactory bulb*. Both the tract and the bulb lie upon the olfactory sulcus on the orbital surface of the frontal lobe, whilst the inferior surface of the bulb rests on the cribriform plate of the ethmoid bone, and receives the numerous olfactory nerves which reach it through the foramina in that part of the cranial floor.

Posteriorly, the olfactory tract will be seen to divide into two diverging roots of attachment. The *mesial root* curves abruptly inwards, and may be followed into the extremity of the callosal and sub-callosal gyri. The *lateral root* runs backwards and outwards over the outer part of the locus perforatus anticus, and gradually disappears from view. In animals, in which the olfactory apparatus is better developed than in man, it may be traced into the uncinate extremity of the hippocampal convolution.

The *gyrus sub-callosus* is a narrow cortical strip, of some morphological importance, which lies in the mesial surface of the hemisphere immediately below the genu of the corpus callosum.

The *trigonum olfactorium* is the little triangular field of grey matter which occupies the interval between the roots of the olfactory tract at the point where they begin to diverge.

Limbic or Falciform Lobe.—This lobe is seen on the mesial surface of the hemisphere, in the form of an elongated ring-like convolution, the extremities of which approach closely to each other at the locus perforatus anticus. These extremities are connected by the roots of the olfactory tract, and in this manner the limbic ring may be considered to be closed.

The upper part of the limbic lobe is placed in intimate relation to the extremities and upper surface of the corpus callosum, and receives the name of *callosal convolution* or *gyrus fornicatus.* The lower portion of the lobe is termed the *hippocampal convolution*, and forms the inner part of the tentorial face of the hemisphere. The continuity between the hippocampal gyrus and the callosal convolution is established below the hinder end of the corpus callosum posteriorly by a narrow portion of the limbic lobe called the *isthmus.* From this point the hippocampal gyrus extends forwards towards the temporal pole. Finally, on the side of the crus cerebri, the hippocampal convolution is folded back on itself, and ends in a recurved hook-like extremity, termed the *uncus.* The uncus does not reach so far forwards as the temporal pole.

The *callosal convolution* begins below the anterior end of the corpus callosum at the locus perforatus anticus, and, winding round the genu of the callosum, it is continued backwards on its upper surface to the hinder thickened extremity or splenium. Finally, curving round this, it becomes greatly narrowed through the calcarine fissure cutting into it. This narrow part is termed the *isthmus*, and constitutes the link of connexion between the callosal gyrus and the hippocampal gyrus.

The callosal gyrus is separated from the marginal convolution by the calloso-marginal fissure. Behind this it is imperfectly marked off from the præcuneus by the post-limbic sulcus. From the corpus callosum it is separated by the *callosal sulcus.*

The *hippocampal convolution* is bounded on the outer side by the anterior part of the collateral sulcus, and in front of this by the incisura temporalis, which separates its hooked extremity, or uncus, from the temporal pole. On its inner side it is limited by the hippocampal or dentate fissure; whilst posteriorly it is divided into two parts by the anterior extremity of the calcarine fissure. Of these, the upper is the isthmus, which connects it with the callosal gyrus, whilst the lower portion brings it into direct continuity with the gyrus lingualis or infra-calcarine convolution.

If the dentate fissure which lies along the inner side of the hippocampal convolution be now opened up, the *gyrus dentatus* and the *fimbria* lying side by side will be brought into view.

Fimbria (Fig. 176).—This is simply a portion of the posterior pillar of the fornix prolonged into this region. It is a conspicuous band of white matter, which presents a prominent free border. In front, it runs into the recurved extremity of the uncus, whilst, if it be traced backwards, it will be seen to curve upwards behind the posterior end of the optic thalamus and become continuous with the posterior pillar of the fornix below the hinder part of the corpus callosum.

Gyrus Dentatus (dentate fascia).—The gyrus dentatus is the free edge of grey matter which is placed between the fimbria and the deep part of the upper surface of the hippocampal convolution. The groove between it and the fimbria is termed the *fimbrio-dentate sulcus*. It is slightly notched along the margin, whilst its surface is scored by numerous parallel and closely-placed transverse grooves. It begins behind in the region of the splenium (the thickened posterior end of the corpus callosum), and it is carried forwards into the cleft of the uncus. From this it emerges in the form of a delicate band which crosses the surface of the recurved part of the uncus in a transverse direction, thereby constituting the *frenulum Giacomini*.

Dentate Fissure.—This is a complete fissure, and the elevation on the ventricular wall, which corresponds to it, is called the hippocampus major (Fig. 176). It begins behind the splenium of the corpus callosum, where it is continuous with a shallow part of the callosal fissure, and it proceeds forwards between the gyrus dentatus and the hippocampal convolution. Its anterior end is enclosed within the uncus.

THE CORPUS CALLOSUM.

A dissection should now be made with the view of exposing the upper surface of the corpus callosum—the commissural band which stretches across between the cerebral hemispheres *at the bottom* of the great longitudinal fissure.

Dissection.—With a long knife slice off the top of the right hemisphere at the level of the calloso-marginal fissure. The white medullary centre of the cerebral hemisphere, enclosed on all hands by the grey cortex, is brought into view, and the appearance receives the name of *centrum ovale minus.* From the central white mass medullary prolongations proceed into all the convolutions.

A transverse incision may next be made through the middle of the callosal convolution, and insinuating the fingers gently under it the dissector should proceed to tear it away from the hemisphere in an outward direction. If this be carried out successfully, the manner in which the fibres of the corpus callosum enter the hemisphere will be seen. In cases where the student is dissecting the brain for the second time, the knife should not be used at all in carrying out this dissection. The top of the hemisphere down to the level of the calloso-marginal fissure should, in the first instance, be torn off, and then the callosal convolutions may be treated in the same way. By this expedient the fibres of the callosum may be traced into the convolutions.

Cingulum.—If the deep surface of the callosal convolution which has been torn away be examined, a large bundle of longitudinally directed fibres will be noticed embedded in its substance. This is the cingulum. It can be easily dislodged; a very slight degree of traction is all that is required to lift it out of its bed. In front, it begins at the locus perforatus anticus, whilst behind, it turns round the hinder end of the callosum, and enters the hippocampal convolution. The cingulum is a long association bundle composed of several systems of fibres which only run for short distances within it. It is closely associated with the limbic lobe.

Dissection.—The gyri and sulci on the mesial surface of the left hemisphere may now be studied, and then the dissection, which has been carried out with the view of exposing the corpus callosum, may be repeated on the left side. In doing this, however, take care not to injure the mesial surface of the left hemisphere farther back than the parieto-occipital fissure. Indeed, an effort should be made to preserve that fissure intact, so that it and the cuneus may be afterwards studied on this side in connexion with the gyri and sulci on the under surface of the hemisphere.

The upper surface of the corpus callosum is now exposed, and it will be seen that, stretching between the two hemispheres, it unites into one mass the two medullary centres of the two hemispheres. The continuous white field, consisting of the corpus callosum and the medullary centre of each hemisphere, receives the name of *centrum ovale majus.*

Corpus Callosum.—This is the great transverse commissure of the cerebrum. It is placed nearer the anterior than the posterior end of the brain, and it unites the inner surfaces of the two cerebral hemispheres throughout very nearly a half of their antero-posterior length. Looked at as a whole, it is arched from before backwards, and presents a convex upper surface and a concave lower surface.

The *upper surface* of the corpus callosum forms the bottom of the great longitudinal fissure, and on each side of this it is covered by the callosal convolution. Only in its posterior part is it touched by the falx cerebri; in front, this process of dura mater falls considerably short of it. The upper surface of the callosum is coated by an exceedingly thin layer of grey matter continuous at the bottom of the callosal sulcus with the grey cortex on the surface of the hemisphere. In this are embedded on either side of the mesial plane two delicate longitudinal bands of fibres called respectively the stria longitudinalis mesialis and lateralis. The *stria longitudinalis mesialis* is the more strongly marked of the two, and it is separated from its fellow of the opposite side by a faint mesial furrow. The *stria longitudinalis lateralis* is placed farther out. So thin is the grey coating of the corpus callosum

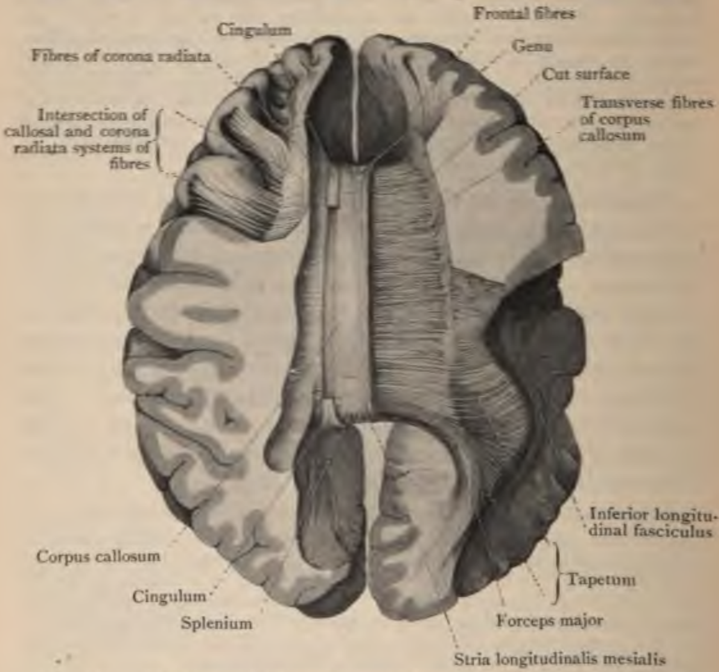
Frontal fibres
Cingulum
Fibres of corona radiata
Genu
Cut surface
Transverse fibres of corpus callosum
Intersection of callosal and corona radiata systems of fibres
Inferior longitudinal fasciculus
Corpus callosum
Tapetum
Cingulum
Splenium
Forceps major
Stria longitudinalis mesialis

FIG. 180.—The Corpus Callosum exposed from above and the Right Half dissected to show the course taken by the Fibres.

that the transverse direction of the bundles of callosal fibres can be easily seen through it.

The striæ with the thin layer of grey matter associated with them represent an aborted convolution called the *gyrus supracallosus*.

The two *extremities* of the corpus callosum (Fig. 181) are greatly thickened, whilst the intermediate part, often called *the body*, is considerably thinner. The massive posterior end, which is full and rounded, lies over the mesencephalon, and extends backwards as far as the highest point of the cerebellum. It is called the *splenium*. The anterior end, which is not quite so massive, is folded downwards and backwards upon itself, and is called the *genu*. The recurved lower portion of the genu is separated from the part of the corpus callosum which lies above by an interval; it rapidly thins as it passes backwards, and is termed the *rostrum*. The fine terminal edge of the rostrum has already been seen to be connected with the lamina cinerea.

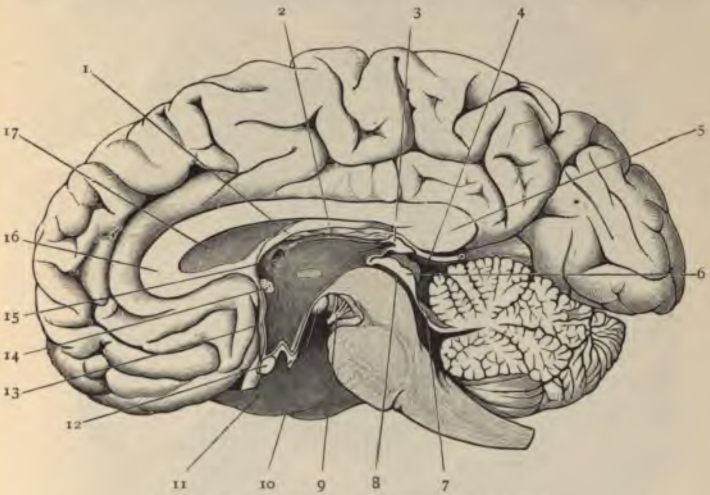

FIG. 181.—Mesial section through the Brain.

1. Fornix.
2. Velum interpositum.
3. Pineal body.
4. Vena magna Galeni.
5. Splenium of corpus callosum.
6. Corpora quadrigemina.
7. Valve of Vieussens.
8. Aqueduct of Sylvius.
9. Oculo-motor nerve.
10. Corpus mammillare.
11. Infundibulum.
12. Optic commissure.
13. Lamina cinerea.
14. Anterior commissure.
15. Foramen of Monro.
16. Genu of corpus callosum.
17. Septum lucidum.

Both the lateral and the mesial longitudinal striæ, when traced backwards, are seen to turn round the splenium, and run into the corresponding gyrus dentatus. In front, the mesial striæ are carried round the genu, and then backwards on the under surface of the rostrum. Finally, each stria runs into the corresponding gyrus subcallosus. Sometimes this gyrus is termed the peduncle of the corpus callosum, and the fibres of the stria which it contains, emerging from its substance, proceed backwards and outwards along the posterior limit of the anterior perforated spot towards the anterior extremity of the temporal lobe.

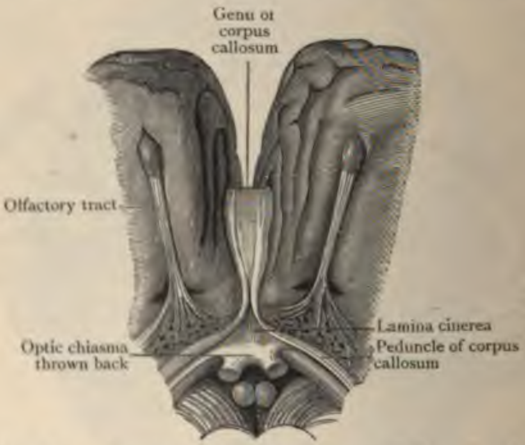

FIG. 182.—Anterior end of the Corpus Callosum and its Peduncles, as seen from below when the frontal lobes of the hemispheres are slightly separated from each other. (From Cruveilhier.)

Fibres of the Corpus Callosum.—The transverse fibres of the corpus callosum, as they enter the white medullary centre of the cerebral hemisphere, radiate from each other so as to reach every part of the cerebral cortex. This radiation is called the *radiatio corporis callosi*. The more anterior of the fibres which compose the genu of the corpus callosum sweep forwards in a series of curves into the prefrontal region of the hemisphere. A large part of the splenium, forming a solid bundle termed the *forceps major*, bends suddenly and abruptly backwards into the occipital lobe. Fibres from the body of the corpus callosum and also from the upper part of the splenium curving round the lateral ventricle form a very definite stratum called the *tapetum*. This is a thin layer in the medullary centre of the hemisphere which forms the roof and outer wall of the posterior horn and the outer wall of the hinder part of the descending horn of the lateral ventricle.

LATERAL VENTRICLE.

The lateral ventricle in the interior of the cerebral hemisphere should now be opened up on each side. The corpus callosum, which forms the roof of the body and anterior horn of this cavity, must therefore be partially removed.

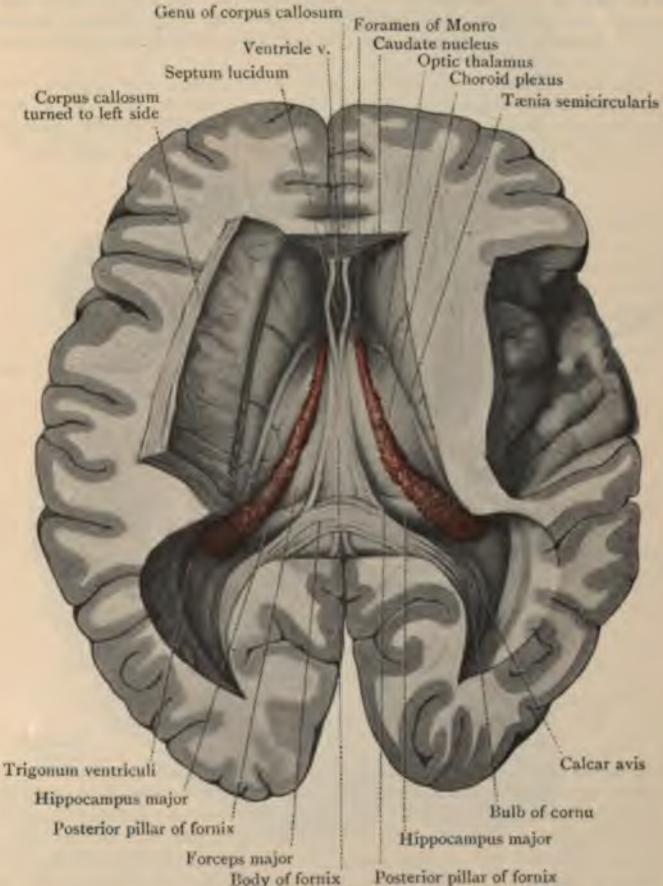
Genu of corpus callosum
Foramen of Monro
Ventricle v.
Caudate nucleus
Optic thalamus
Septum lucidum
Choroid plexus
Corpus callosum turned to left side
Tænia semicircularis
Trigonum ventriculi
Calcar avis
Hippocampus major
Bulb of cornu
Posterior pillar of fornix
Hippocampus major
Forceps major
Body of fornix
Posterior pillar of fornix

FIG. 183.—Dissection to show the Lateral Ventricles. The body of the corpus callosum has been detached from the genu and the splenium and turned over to the left.

Dissection.—Make a longitudinal incision through the corpus callosum about half an inch or less from the mesial plane on each side. The central portion of the corpus callosum which lies between these incisions is to be kept in position. The lateral portions must be turned outwards and detached completely. As this is being done, it will become evident that the lower part of the splenium which is prolonged into the forceps major is in reality a portion folded forwards in close apposition with the under surface of the hinder end of the corpus callosum. Be careful to leave the forceps major in its place.

The body and the anterior horn of the ventricle are now exposed; but the cavity of the ventricle is carried backwards into the occipital lobe in the form of a posterior horn, and downwards and forwards into the temporal lobe in the form of the descending horn. The posterior horn can only at present be opened on the right side. Carry the knife backwards through the medullary substance which forms its roof, and remove a sufficient amount of this to give a complete view of the interior of this part of the cavity. Greater difficulty will be experienced in opening up the descending horn. Place the point of the knife in the upper part of the horn where it joins the body of the ventricle, and carry the blade in a downward and forward direction through the outer part of the temporal lobe towards the temporal pole, following the course of the cavity. This corresponds very nearly with the course of the parallel fissure. The outer wall of the descending horn is thus incised, and a sufficient amount of the outer part of the temporal lobe must be removed to give a view of the cavity. In doing this, the *temporal operculum* will be taken away, but the surface of the insula should *be preserved* from injury.

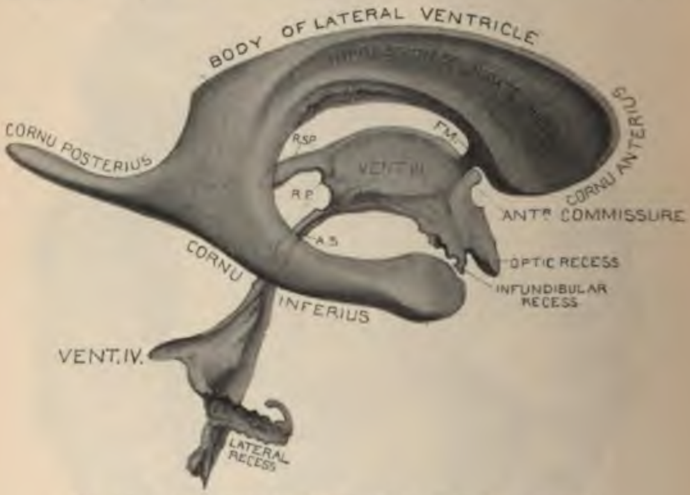

FIG. 184.—Cast of the Ventricles of the Brain (from Retzius).

R.SP. Recessus suprapinealis.
R.P. Recessus pinealis inferior.
A.S. Aqueduct of Sylvius.
F.M. Foramen of Monro.

Lateral Ventricle.—The dissector will now perceive that each cerebral hemisphere is hollow. The cavity in the interior is called the lateral ventricle, and is lined by a thin dark-coloured layer of epithelium, which is termed the *ependyma*. In certain places the walls are in apposition with each other, but in

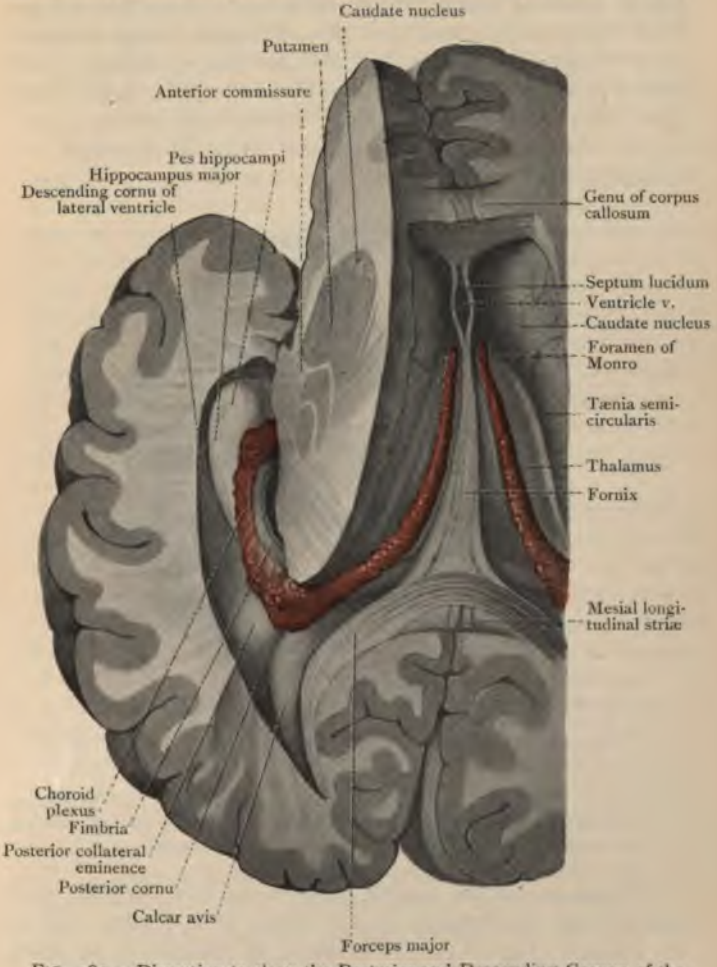
Caudate nucleus
Putamen
Anterior commissure
Pes hippocampi
Hippocampus major
Descending cornu of lateral ventricle
Genu of corpus callosum
Septum lucidum
Ventricle v.
Caudate nucleus
Foramen of Monro
Tænia semicircularis
Thalamus
Fornix
Mesial longitudinal striæ
Choroid plexus
Fimbria
Posterior collateral eminence
Posterior cornu
Calcar avis
Forceps major

FIG. 185.—Dissection to show the Posterior and Descending Cornua of the Lateral Ventricle on the left side.

other localities spaces of varying capacity, and containing cerebro-spinal fluid, are left between the bounding walls. The lateral ventricle communicates with the third ventricle of the brain by means of a small foramen, just large enough to admit a crow-quill, which is termed the *foramen of Monro.* This aperture is placed in front of the fore end of the optic thalamus, and behind the anterior pillar of the fornix.

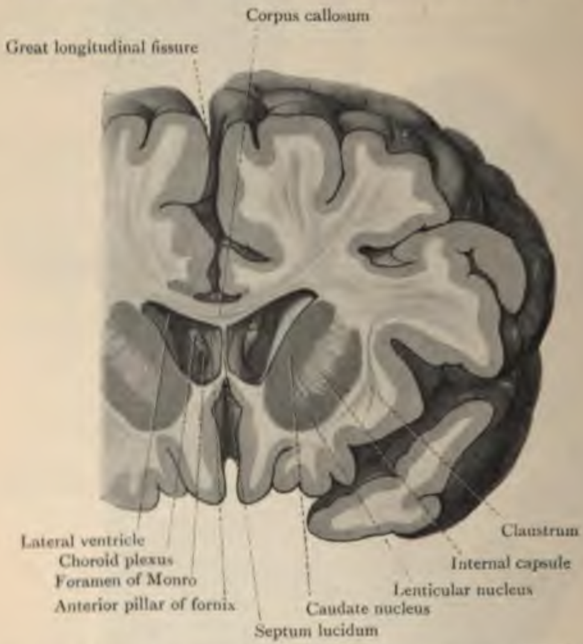
Corpus callosum
Great longitudinal fissure
Lateral ventricle
Choroid plexus
Foramen of Monro
Anterior pillar of fornix
Septum lucidum
Caudate nucleus
Lenticular nucleus
Internal capsule
Claustrum

FIG. 186.—Coronal section through the Cerebrum so as to cut through the anterior part (putamen) of the lenticular nucleus. The anterior cut surface of the posterior part of the cerebrum is depicted.

The shape of the lateral ventricle is very irregular, and can be best understood by the study of a plaster cast of its interior (Fig. 184). It is usual to describe it as being composed of a body and three horns, viz., an anterior, a posterior, and a descending horn. The *anterior horn* is that part of the cavity which lies in front of the foramen of Monro. The *body* is the portion of the ventricle which extends from the foramen of Monro to the splenium of the corpus callosum.

At this point the posterior and descending horns diverge from the hinder end of the body. The *posterior horn* curves backwards and inwards into the occipital lobe. It is very variable in its length and capacity. The *descending horn* proceeds with a bold sweep round the hinder end of the optic thalamus, and then tunnels in a forward and inward direction through the temporal lobe towards the temporal pole.

Anterior Horn of the Lateral Ventricle.—The anterior horn forms the foremost part of the cavity, and extends in a forward and outward direction in the frontal lobe. When seen in coronal section it presents a triangular outline—the floor sloping upwards and outwards to meet the roof at an acute angle (Fig. 186). It is bounded in front by the posterior surface of the genu of the corpus callosum, whilst the *roof* is formed by the fore-part of the same structure. The *inner wall*, which is vertical, is formed by the septum lucidum—a thin mesial partition between the lateral ventricles of opposite sides. The sloping *floor* presents a marked elevation or bulging, viz., the smooth rounded and enlarged anterior extremity of the pear-shaped *caudate nucleus*.

Body of the Lateral Ventricle.—The body of the ventricle is likewise roofed by the corpus callosum. On the *inner* or *mesial side* it is bounded by the hinder part of the septum lucidum, and behind this by the attachment of the fornix to the under surface of the corpus callosum. On the *outer side* it is closed, as in the case of the anterior horn, by the meeting of the roof and the floor of the cavity.

On the *floor* a number of important objects may be recognised. From without inwards, and, at the same time, to some extent from before backwards, these are—(1) the caudate nucleus; (2) a groove which extends obliquely from before backwards and outwards between the caudate nucleus and the optic thalamus, and in which are placed the vein of the corpus striatum and a white band called the tænia semicircularis; (3) a portion of the upper surface of the optic thalamus; (4) the choroid plexus; (5) the thin sharp lateral edge of the fornix.

The *caudate nucleus* as it proceeds backwards on the outer part of the floor of the body of the lateral ventricle narrows very rapidly.

The *vein of the corpus striatum* is exposed in the groove between the caudate nucleus and the optic thalamus, if the ependyma which covers it be scraped away. It joins the vein of Galen at the foramen of Monro. In the same groove is placed the *tænia semicircularis*—a narrow band of white matter, which in the region of the foramen of Monro bends downwards and disappears from view. Its fibres ultimately reach the locus perforatus anticus, in which they end.

The portion of the upper surface of the *optic thalamus*, which appears in the floor of the lateral ventricle, is in great part covered by the *choroid plexus* (plexus choroideus lateralis). The latter is a rich vascular fringe which appears from under cover of the sharp lateral edge of the fornix. In front, it is continuous, behind the foramina of Monro, with the corresponding choroid plexus of the opposite side; whilst behind, it is carried into the descending horn of the ventricle. Although the choroid plexus has all the appearance of lying free within the ventricle, it must be borne in mind that it is invested by an epithelial layer which excludes it from the cavity, and which is connected on the one hand to the sharp margin of the fornix, and on the other to the upper surface of the optic thalamus.

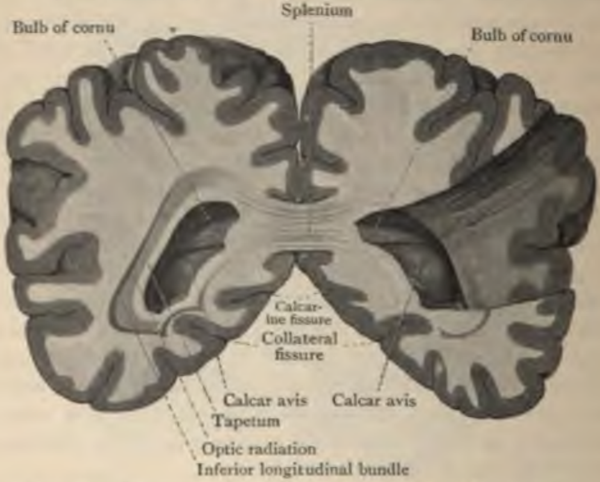
Splenium
Bulb of cornu
Bulb of cornu
Calcar-ine fissure
Collateral fissure
Calcar avis
Calcar avis
Tapetum
Optic radiation
Inferior longitudinal bundle

FIG. 187.—Coronal section through the Posterior Horns of the Lateral Ventricles.

Posterior Horn of the Lateral Ventricle.—The posterior

horn is a diverticulum carried backwards into the occipital lobe from the hinder end of the body of the ventricle. It tapers to a point and describes a gentle curve, the convexity of which is directed outwards. The *roof* and *outer wall* of this portion of the ventricular cavity is formed by the tapetum of the corpus callosum.

Upon the *inner wall* two elongated curved elevations may be observed. The uppermost of these is termed the *bulb of the cornu* (bulbus cornu posterioris), and is produced by the fibres of the forceps major as they curve abruptly backwards from the lower part of the splenium of the corpus callosum into the occipital lobe. Below this is the elevation known as the *hippocampus minor* or the *calcar avis.* It varies greatly in size in different brains, and is caused by an infolding of the ventricular wall in correspondence with the anterior calcarine fissure on the exterior of the hemisphere.

Dissection. — The dissector should now gently insinuate his fingers underneath the fronto-parietal operculum of the insula and tear this portion of the cortex away in an upward direction. The frontal operculum (pars triangularis) and the orbital operculum should be dealt with in the same manner. The greater part of the temporal operculum has already been removed in opening up the descending horn of the ventricle. The insula or island of Reil is therefore fully exposed to view, and its relation to the parts in the interior of the ventricle can be seen.

Descending Horn of the Lateral Ventricle.—The descending horn must be regarded as the direct continuation of the main ventricular cavity into the temporal lobe. The posterior horn is merely a diverticulum carried backwards from the main cavity. At first directed backwards and outwards, the descending horn suddenly sinks downwards behind the optic thalamus into the temporal lobe, in which it takes a curved course forwards and inwards to a point about an inch behind the extremity of the temporal pole. In the angle between the diverging descending and posterior horns the cavity of the ventricle exhibits a triangular expansion of varying capacity. This is called the *trigonum ventriculi.*

The *roof* of the descending horn is formed for the most part by the tapetum of the corpus callosum. At the extremity of the horn the roof presents a slight bulging into the ventricular cavity. This is the *amygdaloid tubercle*, and it is produced by a superjacent collection of grey matter, termed the *amygdaloid nucleus.* The *tænia semicircularis* and the greatly attenuated *tail of the caudate nucleus* are both prolonged

Both the lateral and the mesial longitudinal striæ, when traced backwards, are seen to turn round the splenium, and run into the corresponding gyrus dentatus. In front, the mesial striæ are carried round the genu, and then backwards on the under surface of the rostrum. Finally, each stria runs into the corresponding gyrus subcallosus. Sometimes this gyrus is termed the peduncle of the corpus callosum, and the fibres of the stria which it contains, emerging from its substance, proceed backwards and outwards along the posterior limit of the anterior perforated spot towards the anterior extremity of the temporal lobe.

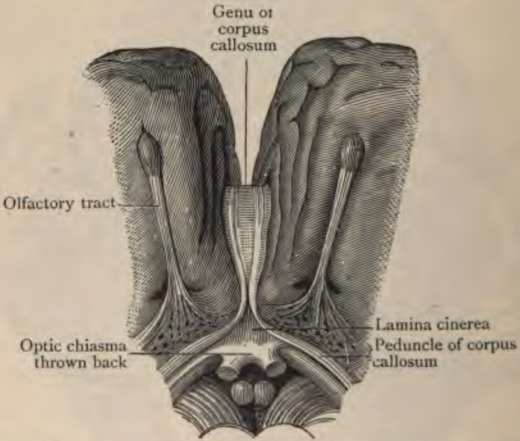

FIG. 182. — Anterior end of the Corpus Callosum and its Peduncles, as seen from below when the frontal lobes of the hemispheres are slightly separated from each other. (From Cruveilhier.)

Fibres of the Corpus Callosum.—The transverse fibres of the corpus callosum, as they enter the white medullary centre of the cerebral hemisphere, radiate from each other so as to reach every part of the cerebral cortex. This radiation is called the *radiatio corporis callosi*. The more anterior of the fibres which compose the genu of the corpus callosum sweep forwards in a series of curves into the prefrontal region of the hemisphere. A large part of the splenium, forming a solid bundle termed the *forceps major*, bends suddenly and abruptly backwards into the occipital lobe. Fibres from the body of the corpus callosum and also from the upper part of the splenium curving round the lateral ventricle form a very definite stratum called the *tapetum*. This is a thin layer in the medullary centre of the hemisphere which forms the roof and outer wall of the posterior horn and the outer wall of the hinder part of the descending horn of the lateral ventricle.

LATERAL VENTRICLE.

The lateral ventricle in the interior of the cerebral hemisphere should now be opened up on each side. The corpus callosum, which forms the roof of the body and anterior horn of this cavity, must therefore be partially removed.

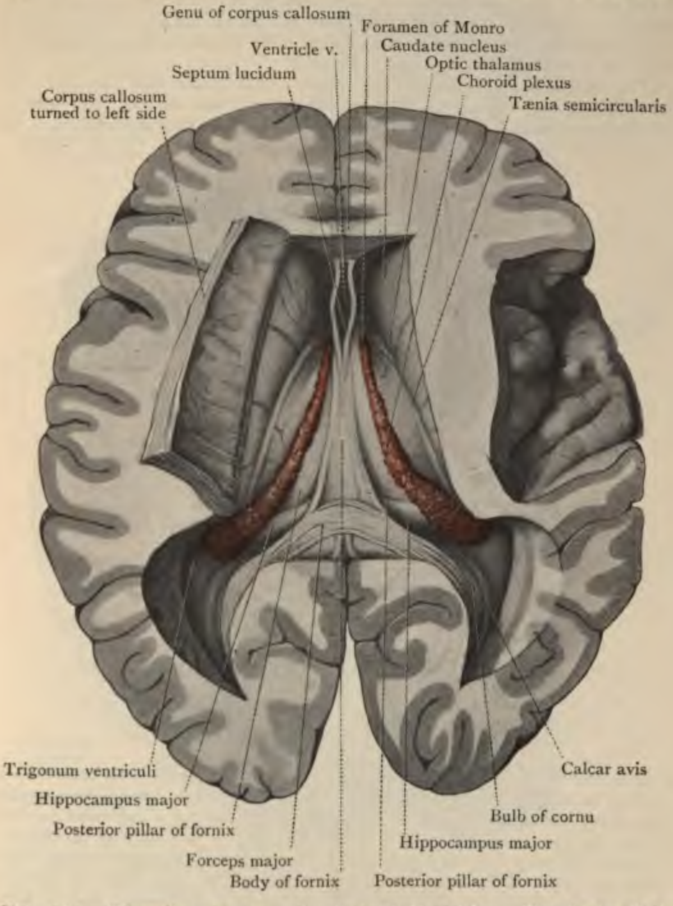
Genu of corpus callosum
Foramen of Monro
Ventricle v.
Caudate nucleus
Optic thalamus
Septum lucidum
Choroid plexus
Corpus callosum turned to left side
Tænia semicircularis
Trigonum ventriculi
Calcar avis
Hippocampus major
Bulb of cornu
Posterior pillar of fornix
Hippocampus major
Forceps major
Body of fornix
Posterior pillar of fornix

FIG. 183.—Dissection to show the Lateral Ventricles. The body of the corpus callosum has been detached from the genu and the splenium and turned over to the left.

Dissection.—Make a longitudinal incision through the corpus callosum about half an inch or less from the mesial plane on each side. The central portion of the corpus callosum which lies between these incisions is to be kept in position. The lateral portions must be turned outwards and detached completely. As this is being done, it will become evident that the lower part of the splenium which is prolonged into the forceps major is in reality a portion folded forwards in close apposition with the under surface of the hinder end of the corpus callosum. Be careful to leave the forceps major in its place.

The body and the anterior horn of the ventricle are now exposed; but the cavity of the ventricle is carried backwards into the occipital lobe in the form of a posterior horn, and downwards and forwards into the temporal lobe in the form of the descending horn. The posterior horn can only at present be opened on the right side. Carry the knife backwards through the medullary substance which forms its roof, and remove a sufficient amount of this to give a complete view of the interior of this part of the cavity. Greater difficulty will be experienced in opening up the descending horn. Place the point of the knife in the upper part of the horn where it joins the body of the ventricle, and carry the blade in a downward and forward direction through the outer part of the temporal lobe towards the temporal pole, following the course of the cavity. This corresponds very nearly with the course of the parallel fissure. The outer wall of the descending horn is thus incised, and a sufficient amount of the outer part of the temporal lobe must be removed to give a view of the cavity. In doing this, the temporal operculum will be taken away, but the surface of the insula should be preserved from injury.

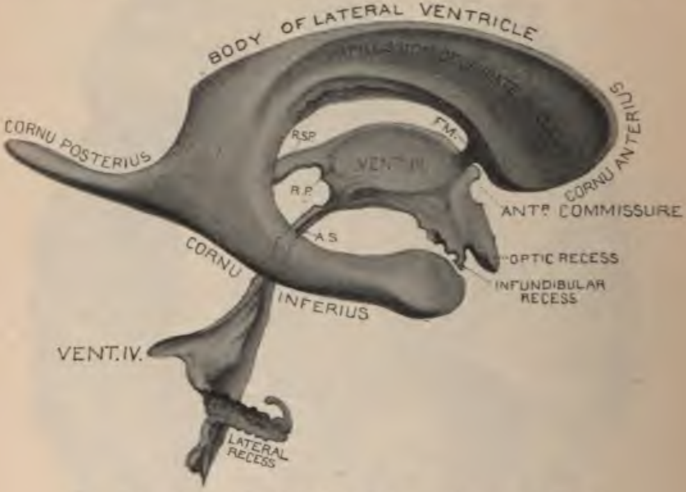

FIG. 184.—Cast of the Ventricles of the Brain (from Retzius).

R.SP. Recessus suprapinealis.
R.P. Recessus pinealis inferior.
A.S. Aqueduct of Sylvius.
F.M. Foramen of Monro.

Lateral Ventricle.—The dissector will now perceive that each cerebral hemisphere is hollow. The cavity in the interior is called the lateral ventricle, and is lined by a thin dark-coloured layer of epithelium, which is termed the *ependyma*. In certain places the walls are in apposition with each other, but in

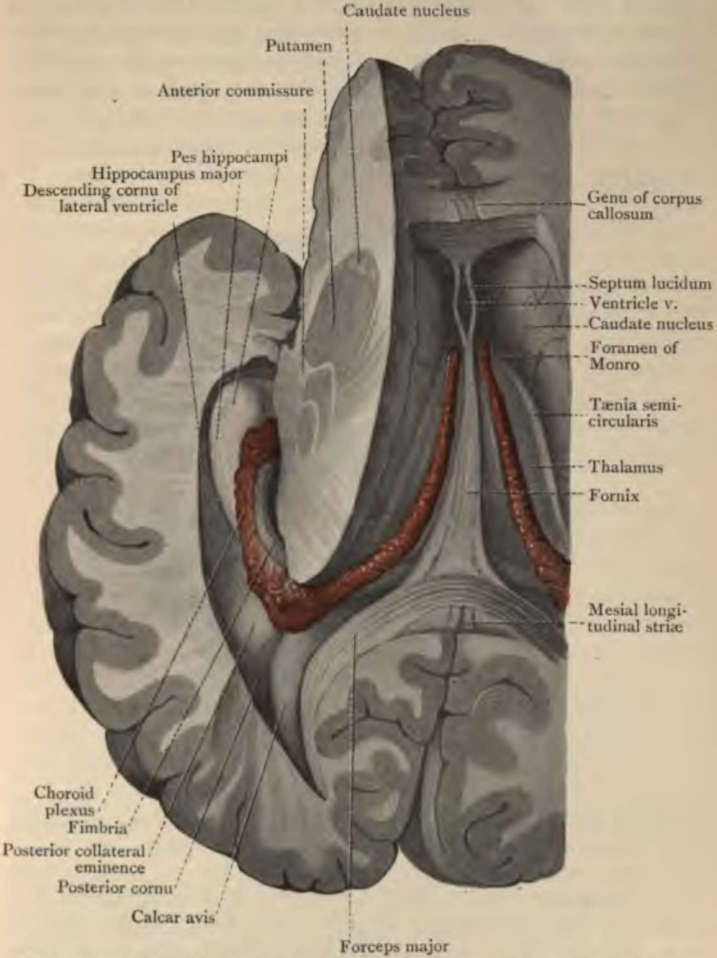
Caudate nucleus
Putamen
Anterior commissure
Pes hippocampi
Hippocampus major
Descending cornu of lateral ventricle
Genu of corpus callosum
Septum lucidum
Ventricle v.
Caudate nucleus
Foramen of Monro
Tænia semi-circularis
Thalamus
Fornix
Mesial longitudinal striæ
Choroid plexus
Fimbria
Posterior collateral eminence
Posterior cornu
Calcar avis
Forceps major

FIG. 185.—Dissection to show the Posterior and Descending Cornua of the Lateral Ventricle on the left side.

other localities spaces of varying capacity, and containing cerebro-spinal fluid, are left between the bounding walls. The lateral ventricle communicates with the third ventricle of the brain by means of a small foramen, just large enough to admit a crow-quill, which is termed the *foramen of Monro.* This aperture is placed in front of the fore end of the optic thalamus, and behind the anterior pillar of the fornix.

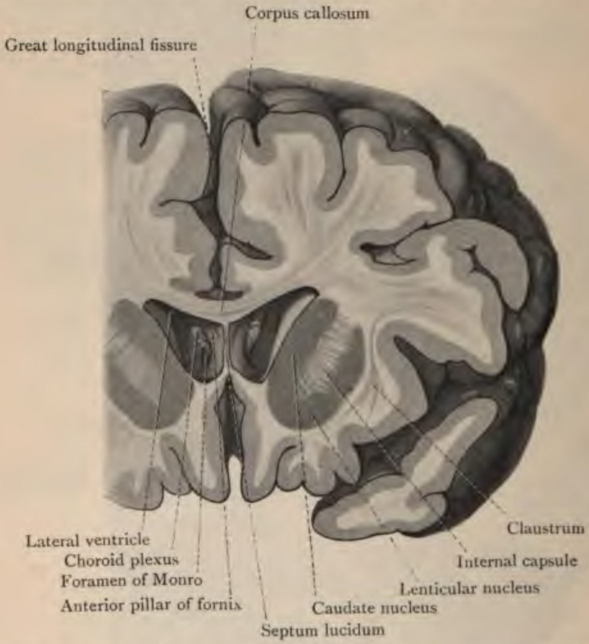
Corpus callosum
Great longitudinal fissure
Lateral ventricle
Choroid plexus
Foramen of Monro
Anterior pillar of fornix
Septum lucidum
Caudate nucleus
Lenticular nucleus
Internal capsule
Claustrum

FIG. 186.—Coronal section through the Cerebrum so as to cut through the anterior part (putamen) of the lenticular nucleus. The anterior cut surface of the posterior part of the cerebrum is depicted.

The shape of the lateral ventricle is very irregular, and can be best understood by the study of a plaster cast of its interior (Fig. 184). It is usual to describe it as being composed of a body and three horns, viz., an anterior, a posterior, and a descending horn. The *anterior horn* is that part of the cavity which lies in front of the foramen of Monro. The *body* is the portion of the ventricle which extends from the foramen of Monro to the splenium of the corpus callosum.

At this point the posterior and descending horns diverge from the hinder end of the body. The *posterior horn* curves backwards and inwards into the occipital lobe. It is very variable in its length and capacity. The *descending horn* proceeds with a bold sweep round the hinder end of the optic thalamus, and then tunnels in a forward and inward direction through the temporal lobe towards the temporal pole.

Anterior Horn of the Lateral Ventricle.—The anterior horn forms the foremost part of the cavity, and extends in a forward and outward direction in the frontal lobe. When seen in coronal section it presents a triangular outline—the floor sloping upwards and outwards to meet the roof at an acute angle (Fig. 186). It is bounded in front by the posterior surface of the genu of the corpus callosum, whilst the *roof* is formed by the fore-part of the same structure. The *inner wall*, which is vertical, is formed by the septum lucidum—a thin mesial partition between the lateral ventricles of opposite sides. The sloping *floor* presents a marked elevation or bulging, viz., the smooth rounded and enlarged anterior extremity of the pear-shaped *caudate nucleus.*

Body of the Lateral Ventricle.—The body of the ventricle is likewise roofed by the corpus callosum. On the *inner* or *mesial side* it is bounded by the hinder part of the septum lucidum, and behind this by the attachment of the fornix to the under surface of the corpus callosum. On the *outer side* it is closed, as in the case of the anterior horn, by the meeting of the roof and the floor of the cavity.

On the *floor* a number of important objects may be recognised. From without inwards, and, at the same time, to some extent from before backwards, these are—(1) the caudate nucleus; (2) a groove which extends obliquely from before backwards and outwards between the caudate nucleus and the optic thalamus, and in which are placed the vein of the corpus striatum and a white band called the tænia semicircularis; (3) a portion of the upper surface of the optic thalamus; (4) the choroid plexus; (5) the thin sharp lateral edge of the fornix.

The *caudate nucleus* as it proceeds backwards on the outer part of the floor of the body of the lateral ventricle narrows very rapidly.

The *vein of the corpus striatum* is exposed in the groove between the caudate nucleus and the optic thalamus, if the ependyma which covers it be scraped away. It joins the vein of Galen at the foramen of Monro. In the same groove is placed the *tænia semicircularis*—a narrow band of white matter, which in the region of the foramen of Monro bends downwards and disappears from view. Its fibres ultimately reach the locus perforatus anticus, in which they end.

The portion of the upper surface of the *optic thalamus*, which appears in the floor of the lateral ventricle, is in great part covered by the *choroid plexus* (plexus choroideus lateralis). The latter is a rich vascular fringe which appears from under cover of the sharp lateral edge of the fornix. In front, it is continuous, behind the foramina of Monro, with the corresponding choroid plexus of the opposite side; whilst behind, it is carried into the descending horn of the ventricle. Although the choroid plexus has all the appearance of lying free within the ventricle, it must be borne in mind that it is invested by an epithelial layer which excludes it from the cavity, and which is connected on the one hand to the sharp margin of the fornix, and on the other to the upper surface of the optic thalamus.

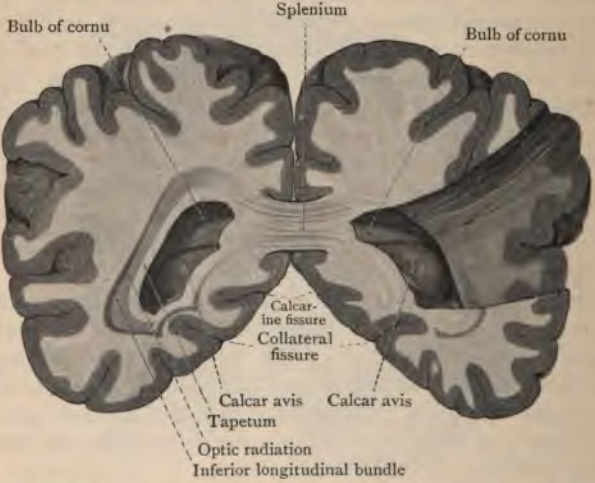
Splenium
Bulb of cornu
Bulb of cornu
Calcarine fissure
Collateral fissure
Calcar avis
Calcar avis
Tapetum
Optic radiation
Inferior longitudinal bundle

FIG. 187.—Coronal section through the Posterior Horns of the Lateral Ventricles.

Posterior Horn of the Lateral Ventricle.—The posterior

horn is a diverticulum carried backwards into the occipital lobe from the hinder end of the body of the ventricle. It tapers to a point and describes a gentle curve, the convexity of which is directed outwards. The *roof* and *outer wall* of this portion of the ventricular cavity is formed by the tapetum of the corpus callosum.

Upon the *inner wall* two elongated curved elevations may be observed. The uppermost of these is termed the *bulb of the cornu* (bulbus cornu posterioris), and is produced by the fibres of the forceps major as they curve abruptly backwards from the lower part of the splenium of the corpus callosum into the occipital lobe. Below this is the elevation known as the *hippocampus minor* or the *calcar avis*. It varies greatly in size in different brains, and is caused by an infolding of the ventricular wall in correspondence with the anterior calcarine fissure on the exterior of the hemisphere.

Dissection.—The dissector should now gently insinuate his fingers underneath the fronto-parietal operculum of the insula and tear this portion of the cortex away in an upward direction. The frontal operculum (pars triangularis) and the orbital operculum should be dealt with in the same manner. The greater part of the temporal operculum has already been removed in opening up the descending horn of the ventricle. The insula or island of Reil is therefore fully exposed to view, and its relation to the parts in the interior of the ventricle can be seen.

Descending Horn of the Lateral Ventricle.—The descending horn must be regarded as the direct continuation of the main ventricular cavity into the temporal lobe. The posterior horn is merely a diverticulum carried backwards from the main cavity. At first directed backwards and outwards, the descending horn suddenly sinks downwards behind the optic thalamus into the temporal lobe, in which it takes a curved course forwards and inwards to a point about an inch behind the extremity of the temporal pole. In the angle between the diverging descending and posterior horns the cavity of the ventricle exhibits a triangular expansion of varying capacity. This is called the *trigonum ventriculi*.

The *roof* of the descending horn is formed for the most part by the tapetum of the corpus callosum. At the extremity of the horn the roof presents a slight bulging into the ventricular cavity. This is the *amygdaloid tubercle*, and it is produced by a superjacent collection of grey matter, termed the *amygdaloid nucleus*. The *tænia semicircularis* and the greatly attenuated *tail of the caudate nucleus* are both prolonged into the descending horn, and are carried forwards in its roof to the amygdaloid nucleus.

On the *floor* of the descending horn the dissector will observe the following parts: (1) the hippocampus major; (2) the choroid plexus; (3) the fimbria; and (4) the eminentia collateralis.

Hippocampus Major (cornu ammonis).—This is for the most part covered by the choroid plexus. It is a prominent elevation on the floor of the descending horn of the lateral ventricle, and is strongly curved in conformity with the course taken by the horn in which it lies. It therefore presents an internal concave border and an external convex margin. Narrow behind, it enlarges as it is traced forwards, and it ends below the amygdaloid tubercle in a thickened extremity which presents some faint grooves or notches on its surface. In consequence of this, the anterior end of the hippocampus major receives the name of the *pes hippocampi*. The hippocampus major is the internal elevation which corresponds to the dentate or hippocampal fissure on the exterior of the cerebrum.

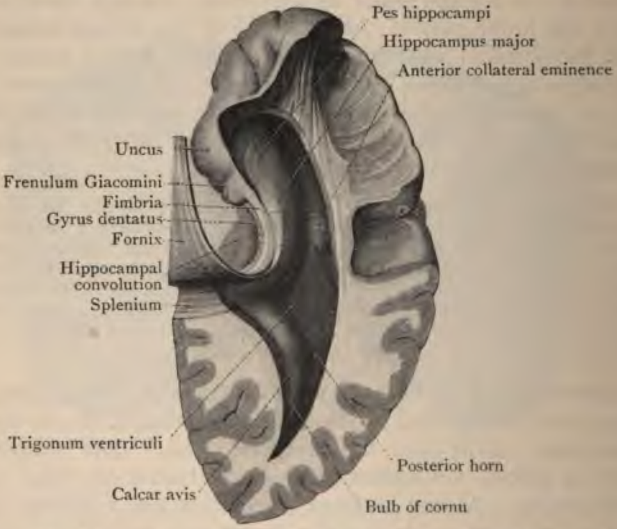
Pes hippocampi
Hippocampus major
Anterior collateral eminence
Uncus
Frenulum Giacomini
Fimbria
Gyrus dentatus
Fornix
Hippocampal convolution
Splenium
Trigonum ventriculi
Calcar avis
Posterior horn
Bulb of cornu

FIG. 188.—Dissection to show the Posterior and Descending Cornua of the Lateral Ventricle.

horn is a diverticulum carried backwards into the occipital lobe from the hinder end of the body of the ventricle. It tapers to a point and describes a gentle curve, the convexity of which is directed outwards. The *roof* and *outer wall* of this portion of the ventricular cavity is formed by the tapetum of the corpus callosum.

Upon the *inner wall* two elongated curved elevations may be observed. The uppermost of these is termed the *bulb of the cornu* (bulbus cornu posterioris), and is produced by the fibres of the forceps major as they curve abruptly backwards from the lower part of the splenium of the corpus callosum into the occipital lobe. Below this is the elevation known as the *hippocampus minor* or the *calcar avis.* It varies greatly in size in different brains, and is caused by an infolding of the ventricular wall in correspondence with the anterior calcarine fissure on the exterior of the hemisphere.

Dissection.—The dissector should now gently insinuate his fingers underneath the fronto-parietal operculum of the insula and tear this portion of the cortex away in an upward direction. The frontal operculum (pars triangularis) and the orbital operculum should be dealt with in the same manner. The greater part of the temporal operculum has already been removed in opening up the descending horn of the ventricle. The insula or island of Reil is therefore fully exposed to view, and its relation to the parts in the interior of the ventricle can be seen.

Descending Horn of the Lateral Ventricle.—The descending horn must be regarded as the direct continuation of the main ventricular cavity into the temporal lobe. The posterior horn is merely a diverticulum carried backwards from the main cavity. At first directed backwards and outwards, the descending horn suddenly sinks downwards behind the optic thalamus into the temporal lobe, in which it takes a curved course forwards and inwards to a point about an inch behind the extremity of the temporal pole. In the angle between the diverging descending and posterior horns the cavity of the ventricle exhibits a triangular expansion of varying capacity. This is called the *trigonum ventriculi.*

The *roof* of the descending horn is formed for the most part by the tapetum of the corpus callosum. At the extremity of the horn the roof presents a slight bulging into the ventricular cavity. This is the *amygdaloid tubercle*, and it is produced by a superjacent collection of grey matter, termed the *amygdaloid nucleus.* The *tænia semicircularis* and the greatly attenuated *tail of the caudate nucleus* are both prolonged examined in connexion with the hippocampal fissure and the gyrus dentatus, and the relations which it presents to the posterior pillar of the fornix and the uncus have been pointed out (p. 482).

Choroid Fissure of the Cerebrum.—When the pia mater in the region of the hippocampal fissure is removed from the surface of the brain, the choroid plexus in the interior of the descending horn of the lateral ventricle is usually withdrawn with it, and a fissure appears between the fimbria and the roof of the ventricular horn. This is termed the *choroid fissure of the cerebrum*, or the lower part of the *great transverse fissure*. By the withdrawal of the choroid plexus, it is converted into an artificial gap which leads directly from the exterior of the brain into the interior of the descending horn of the lateral ventricle (Fig. 189).

Choroid Plexus. — The choroid plexus is a system of convoluted blood-vessels in connexion with a fold of pia mater which is prolonged into the descending horn of the lateral ventricle through the choroid fissure of the cerebrum. It lies on the surface of the hippocampus major, and is continuous behind the posterior border of the optic thalamus with the choroid plexus in the body of the lateral ventricle. But it must not be supposed that the choroid plexus lies free in the ventricular cavity. It is clothed in the most intimate manner by an epithelial layer, which represents the inner or mesial wall of the descending horn pushed into the cavity by the choroid plexus. The ventricle, therefore, only opens on the surface through the choroid cerebral fissure when this thin epithelial layer is torn away by the withdrawal of the choroid plexus.

Eminentia Collateralis.—This eminence may present two distinct forms, which may be distinguished from each other as the eminentia collateralis posterior and the eminentia collateralis anterior.

The *posterior collateral eminence* is a smooth elevation in the floor of the trigonum ventriculi, in the interval between the calcar avis and the hippocampus major as they diverge from each other. The *anterior collateral eminence* is not always present. It forms an elongated elevation on the floor of the descending horn of the lateral ventricle, on the outer side of the hippocampus major. Both eminences correspond to the collateral fissure on the inferior aspect of the cerebral hemisphere.

Dissection.—The remains of the right temporal lobe and of the right occipital lobe should now be detached from the cerebrum by cutting through the fimbria where it passes into the posterior pillar of the fornix and the forceps major of the splenium of the corpus callosum. The knife should then be carried forwards from the anterior extremity of the descending horn above the level of the uncus through the temporal pole. The temporal lobe, with the hippocampal convolution along its inner side, can then be separated from the remainder of the brain, along the line of the choroid fissure of the cerebrum. In the detached part of the cerebrum (Fig. 189) a good view is obtained of the floor of the descending horn and of the parts in relation to it. Further, by replacing it in position, the choroid cerebral fissure can be better understood, and by turning the brain upside down a view of the roof of the descending horn and the structures in relation to it is gained. In this way the tail of the caudate nucleus and the tænia semicircularis can be traced into the amygdaloid nucleus.

The cut edge of the central part of the corpus callosum, which is still in position, should now be still farther pared away, so as to bring more fully into view the subjacent septum lucidum and the fornix.

SEPTUM LUCIDUM—FORNIX—VELUM INTERPOSITUM.

Septum Lucidum (septum pellucidum).—This is a thin vertical partition which intervenes between the anterior cornua and the fore-parts of the bodies of the two lateral ventricles (Fig. 183). It is triangular in shape, and posteriorly it is prolonged backwards in the narrow interval between the body of the corpus callosum and the fornix, to both of which it is attached by its upper and lower edges. In front, it occupies the gap behind the genu of the corpus callosum; whilst below, in the narrow interval between the rostrum of the corpus callosum and the fornix, it is prolonged downwards to the base of the brain.

The septum lucidum is composed of two thin laminæ in apposition with each other in the mesial plane. The mesial cleft between the layers is termed the *fifth ventricle* (Figs. 183 and 185).

Dissection.—The narrow middle strip of the corpus callosum, behind the bend of the genu, should now be removed. Cut it transversely across behind the genu, and, gently raising it, separate the upper edge of the septum lucidum from its lower surface. Farther back, behind the septum lucidum, it will be found to lie upon and to be anatomically connected with the upper surface of the fornix. This connexion must also be severed. The left forceps major should be preserved, so that its connexion with the occipital lobe may be more fully made out at a later stage. By snipping off the upper edge of the septum lucidum with the scissors, the two laminæ, with the interposed cleft or fifth ventricle, will be exposed.

Fifth Ventricle.—This is the name which is applied to the mesial cleft between the two laminæ of the septum examined in connexion with the hippocampal fissure and the gyrus dentatus, and the relations which it presents to the posterior pillar of the fornix and the uncus have been pointed out (p. 482).

Choroid Fissure of the Cerebrum.—When the pia mater in the region of the hippocampal fissure is removed from the surface of the brain, the choroid plexus in the interior of the descending horn of the lateral ventricle is usually withdrawn with it, and a fissure appears between the fimbria and the roof of the ventricular horn. This is termed the *choroid fissure of the cerebrum*, or the lower part of the *great transverse fissure.* By the withdrawal of the choroid plexus, it is converted into an artificial gap which leads directly from the exterior of the brain into the interior of the descending horn of the lateral ventricle (Fig. 189).

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Fifth Ventricle.—This is the name which is applied to the mesial cleft between the two laminæ of the septum lucidum. It varies greatly in extent in different brains and contains a little fluid. It is completely isolated, and presents no communication with the other ventricles or with the surface. Indeed, the term "ventricle" is somewhat inappropriate, because its developmental history shows that it has nothing in common with the general ventricular system of the brain.

Fornix.—The fornix is an arched bilateral structure, composed of longitudinally directed fibres. In its intermediate part, its two lateral halves are joined together in the mesial plane, and form what is called the body of the fornix; but in front and behind they are quite separate, and constitute the anterior and posterior pillars of the fornix.

The *body of the fornix* is triangular in shape. In front, where it is continuous with the anterior pillars, it is narrow; whilst behind, it broadens out, becomes flattened, and is prolonged into the posterior pillars. The upper surface of the body of the fornix is in contact with the under surface of the corpus callosum, and in the mesial plane is adherent to it, and also to the posterior part of the lower edge of the septum lucidum. Beyond these attachments on each side, the upper surface of the body of the fornix forms a part of the floor of the lateral ventricle, and is clothed by ependyma. It presents a sharp lateral edge, from under which the choroid plexus projects into the cavity of the lateral ventricle, and with which the epithelial layer which covers that plexus is continuous. The lower surface of the body of the fornix rests upon the velum interpositum, a fold of pia mater, which separates it from the third ventricle and the two optic thalami.

The *anterior pillars of the fornix* (columnæ fornicis) are two rounded strands which emerge from the anterior part of the body of the fornix, and then diverge very slightly from each other as they curve downwards in front of the foramen of Monro. Sinking into the grey matter on the lateral wall of the third ventricle, each anterior pillar proceeds downwards to the base of the brain, where it protrudes in the interpeduncular space to take part in the formation of the corpus mammillare.

The corpus mammillare has the appearance of being a twisted loop of the anterior pillar of the fornix, in which the pillar turns upon itself, and is then continued upwards and backwards into the anterior tubercle of the optic thalamus. This appearance, however, is deceptive. In the interior of the corpus mammillare there is a nucleus of grey matter. In this the fibres of the anterior pillar end; while the other fibres which seem to be continuous with the fornix fibres take origin within the nucleus. The strand thus formed is called the *bundle of Vicq d'Azyr.*

The connexions which have just been described cannot be made out at present, but at a later period the dissector will experience little difficulty in tracing the anterior pillar of the fornix to the corpus mammillare, and in displaying the connexion of this with the bundle of Vicq d'Azyr.

The *posterior pillars of the fornix* are flattened bands which diverge widely from the body of the fornix. At first they are adherent to the under surface of the corpus callosum, but soon they sweep downwards round the posterior ends of the optic thalami, and enter the posterior horns of the lateral ventricles. Here each posterior pillar comes into relation with the corresponding hippocampus major, and a portion of its fibres become spread out on the surface of this prominence, forming the *alveus*, whilst the remainder constitute the fimbria, which has already been described (pp. 482, 495).

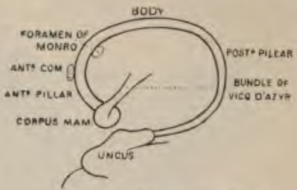

FIG. 190.—Diagram of the Fornix; profile view.

Dissection.—The body of the fornix should now be divided transversely across its middle. Its posterior and anterior portions may then be gently raised from the velum interpositum, and thrown forwards and backwards. Had it been possible to raise the corpus callosum and fornix together, the diverging posterior pillars of the latter would have been seen to limit a triangular space on the under surface of the corpus callosum in front of the posterior margin of the splenium. This interval is termed the *lyra*, and is traversed by a series of oblique and longitudinal markings. These markings indicate the presence of fibres, which pass across from one pillar of the fornix to the other, so as to form a white lamina. This lamina is not united to the under surface of the corpus callosum, and the interval between them is sometimes termed *Verga's ventricle.*

Velum Interpositum.—This lamina is formed by a double layer or fold of pia mater which intervenes between the body of the fornix, which is placed above it, and the roof of the third ventricle and the two optic thalami, which lie below it. Between the two layers are blood vessels and some subarachnoidal trabecular tissue. In shape the velum interpositum is triangular, and the narrow anterior end or apex reaches as far forwards as the foramina of Monro. The base lies under the splenium of the corpus callosum, and here the two layers of pia mater which form the velum become continuous with the investing pia mater on the surface of the brain.

Along each lateral margin the velum interpositum is bordered by the choroid plexus of the body of the lateral ventricle, which projects into the ventricular cavity from under cover of the lateral free edge of the fornix. Posteriorly, this choroid plexus is continuous with the similar structure in the descending horn of the ventricle; whilst in front, it narrows greatly, and becomes continuous, across the mesial plane, with the corresponding plexus of the opposite side, behind the epithelium which lines the foramina of Monro. From this median junction two much smaller choroid plexuses run backwards on the under surface of the velum interpositum, and project downwards into the third ventricle. These are the *choroid plexuses of the third ventricle* (Fig. 192).

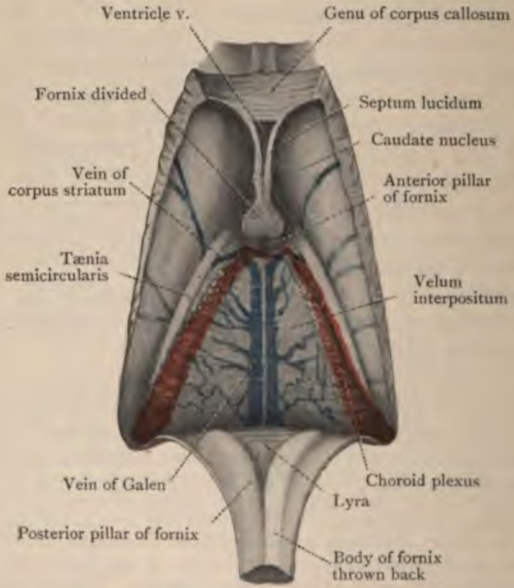
Ventricle v.
Genu of corpus callosum
Fornix divided
Septum lucidum
Caudate nucleus
Vein of corpus striatum
Anterior pillar of fornix
Tænia semicircularis
Velum interpositum
Vein of Galen
Choroid plexus
Lyra
Posterior pillar of fornix
Body of fornix thrown back

FIG. 191.—Dissection to show Velum Interpositum and the parts in its vicinity. The fornix has been divided and thrown back.

The most conspicuous blood vessels in the velum interpositum are the two *veins of Galen*, which run backwards—one on either side of the mesial plane. In front, each is formed at the apex of the fold by the union of the vein of the corpus striatum with a large vein issuing from the choroid plexus; behind, they unite to form the *vena magna Galeni*, and this pours its blood into the anterior end of the straight sinus.

Transverse Fissure.—This name is given to the continuous cleft through which the velum interpositum and the choroid plexuses of the two descending horns of the lateral ventricles are introduced into the interior of the brain. It consists of an upper or intermediate part and two lateral parts. The former passes forwards between the splenium of the corpus callosum and the body of the fornix above, and the roof of the third ventricle and the optic thalami below. It is limited by the epithelial covering of the choroid plexuses, which shuts out these structures from the cavity of the lateral ventricles.

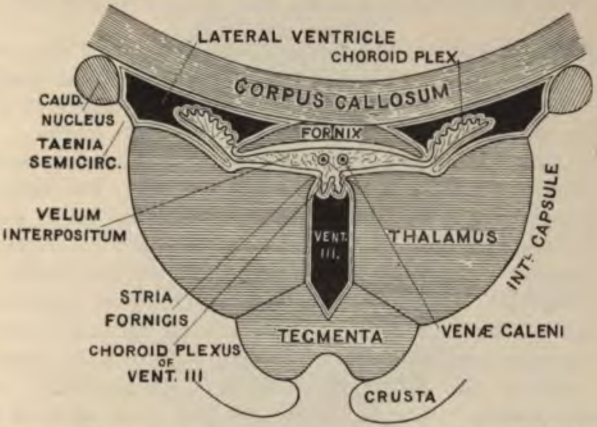
LATERAL VENTRICLE
CHOROID PLEX.
CORPUS CALLOSUM
CAUD. NUCLEUS
FORNIX
TAENIA SEMICIRC.
VELUM INTERPOSITUM
VENT. III.
THALAMUS
INT. CAPSULE
STRIA FORNICIS
CHOROID PLEXUS OF VENT. III
TEGMENTA
VENÆ GALENI
CRUSTA

FIG. 192.—Diagrammatic coronal section through the Optic Thalami and the parts in immediate relation to them. The intermediate part of the great transverse fissure holding the velum interpositum is seen, and also the manner in which this fissure is shut out from the lateral ventricles by the epithelium which covers the choroid plexus on each side.

The lateral part of the transverse fissure is termed the *choroidal fissure*. It is continuous with the intermediate part, and has already been studied in connexion with the descending horn of the lateral ventricle (p. 496).

Dissection.—The vein of the corpus striatum should now be divided on each side as it passes into the vein of Galen. The apex of the velum interpositum should then be seized with the forceps, and the whole structure pulled backwards. The entire upper surface of the optic thalamus on each side is thus exposed, and between these bodies is seen the mesially placed third ventricle. The roof of this ventricle, which is epithelial and invaginated into the cavity by the choroid plexuses on the under surface of the velum interpositum, is torn away with that structure. The basal part of the velum interpositum is intimately connected with the pineal body which lies on the mesencephalon behind the third ventricle. Care therefore must be taken to extricate this body from the pia mater, otherwise it is sure to be pulled away.

THE OPTIC THALAMI AND THE THIRD VENTRICLE.

Optic Thalamus.—The optic thalamus is a large ovoid mass of grey matter which lies obliquely across the path of the crus cerebri as it ascends into the cerebrum. The smaller anterior end of the thalamus lies close to the mesial plane, and is only separated from the corresponding part of the opposite side by a very narrow interval. The enlarged posterior ends of the two thalami are placed more widely apart; and in the interval between, the corpora quadrigemina are situated. In their anterior two-thirds, the two thalami lie close together, and a deep mesial cleft, the third ventricle of the brain, intervenes between them. Each thalamus presents an anterior and a posterior extremity, and four surfaces. The inferior and external surfaces are in apposition, and, indeed, directly connected with adjacent parts, and on this account it is only possible to study them by means of sections through the brain. The superior and internal surfaces are free, and may be examined in the present dissection.

The *external* or *lateral surface* of the optic thalamus is applied to a mass of white matter, termed the *internal capsule*, which is largely composed of fibres derived from the *crusta* or ventral part of the crus cerebri. The *inferior* or *ventral surface* of the thalamus rests chiefly upon the *subthalamic region* or the prolongation upwards of the dorsal tegmental part of the crus cerebri. The relation, therefore, which this body presents to the upward continuation of the crus cerebri is very intimate.

The *superior* or *dorsal surface* of the thalamus is free. On the outer side it is bounded by the groove, already noticed, on the floor of the lateral ventricle which intervenes between the thalamus and the caudate nucleus—a groove which contains the vein of the corpus striatum and the tænia semicircularis. On the inner side the superior surface of the thalamus is separated in its anterior half from the internal or mesial surface by a sharp edge, or prominent ledge, of the ependyma of the third ventricle. This is called the *tænia thalami*, and the ridge which it forms is accentuated by the fact that subjacent to it there lies a longitudinal strand of fibres called the *stria medullaris.* When these two structures, viz., the ependymal ridge and the subjacent tract, are traced backwards, they are seen to turn inwards and become continuous with the stalk of the pineal body. Between the hinder part of the tænia thalami and the thalamus there is a small depressed triangular area, the *trigonum habenulæ*, situated in front of the superior quadrigeminal body.

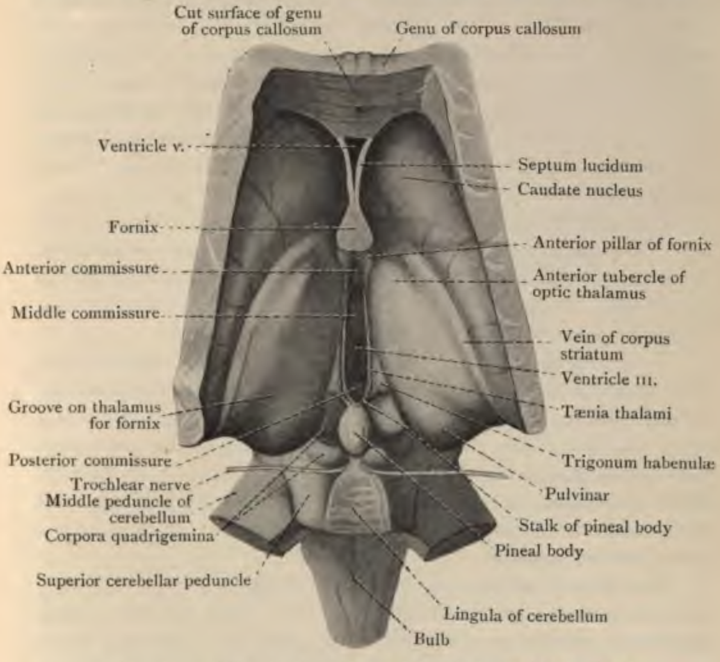
Cut surface of genu of corpus callosum
Genu of corpus callosum
Ventricle v.
Septum lucidum
Caudate nucleus
Fornix
Anterior pillar of fornix
Anterior commissure
Anterior tubercle of optic thalamus
Middle commissure
Vein of corpus striatum
Ventricle III.
Groove on thalamus for fornix
Tænia thalami
Posterior commissure
Trigonum habenulæ
Trochlear nerve
Pulvinar
Middle peduncle of cerebellum
Stalk of pineal body
Corpora quadrigemina
Pineal body
Superior cerebellar peduncle
Lingula of cerebellum
Bulb

FIG. 193.—The two Optic Thalami and the Third Ventricle as seen from above.

The superior surface of the thalamus is slightly bulging or convex, and is of a whitish colour owing to the presence of a thin superficial coating of nerve fibres (stratum zonale). It is divided into two areas by a faint oblique groove which begins in front a short distance behind the anterior extremity of the thalamus, and extends obliquely outwards and backwards. This sulcus corresponds to the free outer edge of the fornix. The two areas thus mapped out are very differently related to the ventricles of the brain. The *outer area* includes the anterior extremity of the thalamus, and forms a part of the floor of the lateral ventricle; it is covered with ependyma, and overlapped by the choroid plexus (Fig. 192). The *inner area* intervenes between the lateral and third ventricles of the brain, and takes no part in the formation of the walls of either. It is covered by the velum interpositum, above which is the fornix. It includes the posterior extremity of the thalamus.

The *anterior extremity* of the thalamus, called the *anterior tubercle* (tuberculum anterius), is rounded and prominent. It projects into the lateral ventricle, lies behind and to the outer side of the free portion of the anterior pillar of the fornix, and bounds the foramen of Monro behind.

The *posterior extremity* of the thalamus is very prominent, and projects backwards so as to overhang a portion of the mesencephalon (viz., the brachia of the quadrigeminal bodies) (Fig. 193). This projecting part is called the *pulvinar*. But the hinder end of the thalamus shows another prominence. This is situated below and to the outer side of the pulvinar. It is oval in form, and receives the name of the *corpus geniculatum externum*.

The *mesial surfaces* of the two thalami are placed very close together, and are covered not only by the lining ependyma of the third ventricle, but also by a tolerably thick layer of grey matter continuous below with the grey matter which surrounds the aqueduct of Sylvius in the mesencephalon. A band of grey matter, termed the *grey* or *soft commissure* of the brain (commissura mollis), crosses the third ventricle and joins the two thalami together.

Pineal Body (corpus pineale).—This is a small body of a darkish colour, and about the size of a cherry-stone, which is placed between the hinder extremities of the two thalami on the dorsal aspect of the mesencephalon (Fig. 193). It occupies the depression between the two superior quadrigeminal bodies, and is shaped like a fir-cone. Its base, which is directed upwards, is attached by means of a hollow stalk or peduncle. This stalk is separated into a dorsal and a ventral part by a continuation backwards into it of a pointed recess of the cavity of the third ventricle. The dorsal part of the stalk is carried forwards on each optic thalamus as the tænia thalami; the ventral part is folded round a narrow but conspicuous cord-like band of white fibres, which crosses the mesial plane immediately above the base of the pineal body, and receives the name of the *posterior commissure* of the cerebrum.

Anterior Commissure of the Cerebrum.—In the anterior part of the cleft between the two optic thalami, and immediately in front of the anterior pillars of the fornix, a round bundle of white fibres will be seen crossing the mesial plane. This is the anterior commissure. It is very much larger than the posterior commissure, and will be afterwards followed towards the temporal lobe in which the greater part of it ends.

Third Ventricle.—This name is given to the deep narrow cleft between the two optic thalami. Its depth rapidly increases from behind forwards, and it may be considered to extend from the pineal body behind to the anterior commissure and lamina cinerea in front. Its *floor* is formed by the parts already studied within the interpeduncular space on the base of the brain, viz., the tuber cinereum, the corpora mammillaria, and the grey matter of the locus perforatus posticus, and also to some extent behind these by the tegmenta of the crura cerebri. *In front*, it is bounded by the lamina cinerea and the anterior commissure; whilst its *lateral walls* are formed by the mesial surfaces of the two optic thalami. A little in front of the middle of the ventricle the cavity is crossed by the *middle or soft commissure*, which connects the thalami with each other, and in front of this the anterior pillar of the fornix is seen descending in the lateral wall. At first this is distinct and prominent, but it gradually becomes more and more sunk in the grey matter on the side of the ventricle as it approaches the corresponding corpus mammillare.

The *roof* of the third ventricle is formed by a thin epithelial layer continuous with the epithelial lining of the cavity, which stretches across the mesial plane from the one tænia thalami to the other. It is applied to the under surface of the velum interpositum which overlies the ventricle, and is invaginated into the cavity by the choroid plexuses which hang down from the under surface of this fold of pia mater. In the removal of the velum interpositum this thin epithelial roof has been torn away.

The third ventricle communicates freely with the lateral ventricles, and also with the fourth ventricle. The *aqueduct of Sylvius*, a narrow channel which tunnels the mesencephalon, brings it into communication with the fourth ventricle. The opening of this aqueduct will be seen at the posterior part of the floor of the ventricle, immediately below the posterior commissure. The *foramina of Monro* bring it into communication with the two lateral ventricles. The latter apertures are placed at the upper and fore parts of the lateral walls, and lead outwards and slightly upwards between the most prominent parts of the anterior pillars of the fornix, and the anterior tubercles of the optic thalami. They are just large enough to admit a crow-quill, and through these passages the epithelial lining of the three ventricles becomes continuous.

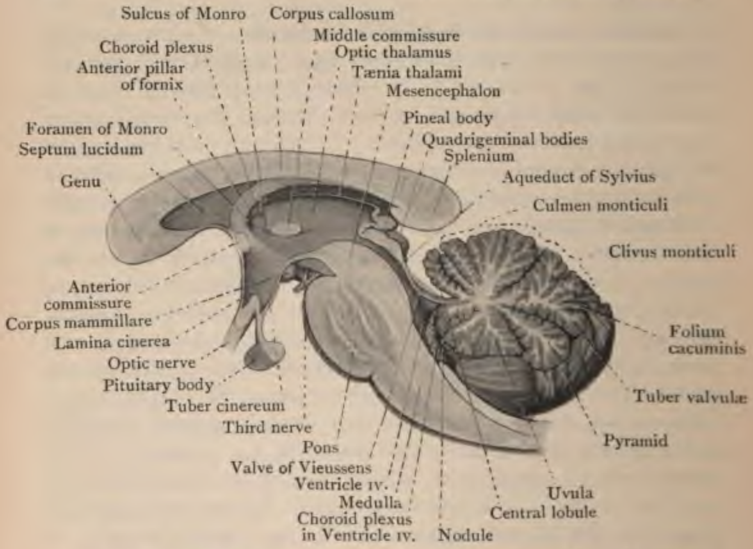
Sulcus of Monro
Corpus callosum
Choroid plexus
Middle commissure
Optic thalamus
Anterior pillar of fornix
Tænia thalami
Mesencephalon
Foramen of Monro
Pineal body
Septum lucidum
Quadrigeminal bodies
Splenium
Genu
Aqueduct of Sylvius
Culmen monticuli
Clivus monticuli
Anterior commissure
Corpus mammillare
Folium cacuminis
Lamina cinerea
Optic nerve
Pituitary body
Tuber valvulæ
Tuber cinereum
Third nerve
Pyramid
Pons
Valve of Vieussens
Ventricle IV.
Uvula
Medulla
Central lobule
Choroid plexus in Ventricle IV.
Nodule

FIG. 194.—Mesial section through the Corpus Callosum, Third Ventricle, Mesencephalon, Pons, Cerebellum, and Medulla.

From the foramen of Monro a distinct groove on the lateral wall of the ventricle leads backwards towards the mouth of the Sylvian aqueduct. It is termed the *sulcus of Monro.*

The outline of the third ventricle, when viewed from the side in a mesial section through the brain (Fig. 184), or as it is exhibited in a plaster cast of the ventricular system of the brain, is seen to be very irregular. It presents several diverticula or recesses. Thus, in the fore-part of the floor there is a deep funnel-shaped pit or recess leading down through the tuber cinereum into the infundibulum of the pituitary body. Another recess leads forwards immediately in front of this, above the optic chiasma. Posteriorly, two additional recesses are present. One, the *recessus pinealis*, passes backwards, above the posterior commissure and the entrance of the aqueduct of Sylvius, for a short distance into the stalk of the pineal body. The second is placed above this, and is carried backwards for a greater distance. Its walls are epithelial, and therefore it cannot be seen in an ordinary dissection. It is termed the *recessus suprapinealis.*

Dissection.—The further study of the cerebrum should be postponed until after the examination of the mid-brain or mesencephalon. The membranes should be removed from the upper surface of the cerebellum, and the prominent anterior part of this organ may then be gently pulled backwards to expose as far as possible the corpora quadrigemina, *i.e.*, the four rounded eminences on the dorsal aspect of the mesencephalon. In doing this, care should be taken to secure and preserve the slender trochlear nerve which winds forwards round the outer side of the crus cerebri, and which issues from a lamina called the valve of Vieussens, immediately below the inferior pair of quadrigeminal bodies.

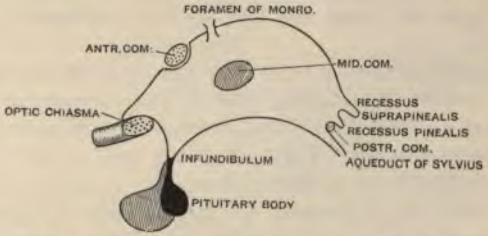

FIG. 195.—Diagrammatic outline of the Third Ventricle as viewed from the side.

THE MESENCEPHALON.

The mesencephalon is the stalk which occupies the opening of the tentorium cerebelli, and connects the cerebrum with the parts in the posterior cranial fossa. It is about three-quarters of an inch long, and it consists of a dorsal part, composed of the corpora quadrigemina, and a much larger ventral part, which is formed by the two large crura cerebri. In the undissected brain the corpora quadrigemina are completely hidden from view by the splenium of the corpus callosum, which projects backwards over them, and also by the superimposed cerebral hemispheres. The crura cerebri, however, can to some extent be seen on the base of the brain, where they bound the posterior part of the interpeduncular space. The mesencephalon is tunnelled from below upwards by a narrow passage called the aqueduct of Sylvius. This channel lies much nearer its dorsal than its ventral surface.

Corpora Quadrigemina (optic lobes).—The four rounded eminences on the dorsal aspect of the mesencephalon to which this name is applied are for the most part composed of grey matter, although each has a superficial coating of white fibres. The *superior pair* are larger and broader than the *inferior pair*, but they are not so well defined nor yet so prominent.

A longitudinal and a transverse groove separate the quadrigeminal bodies from each other. The *longitudinal groove* occupies the mesial plane, and extends upwards as far as the posterior commissure. From its lower end a short but well-defined narrow band of white fibres, the *frenulum veli*, passes to the valve of Vieussens—a lamina placed immediately below the inferior pair of quadrigeminal prominences. The upper part of the longitudinal groove is occupied by the pineal body. The *transverse groove* curves round behind each of the superior pair of quadrigeminal bodies, and separates them from the inferior pair.

Brachia of the Corpora Quadrigemina.—The corpora quadrigemina are not marked off from the side of the mesencephalon, but each body has in connexion with it on this aspect a prominent white strand, which is prolonged upwards and forwards under the projecting pulvinar and corpus geniculatum externum on the hinder end of the optic thalamus. These strands are called the *brachia* of the corpora quadrigemina, and they are separated from each other by a continuation on the side of the mesencephalon of the transverse groove which intervenes between the two pairs of bodies.

Corpus Geniculatum Internum.—Closely connected with the brachia of the corpora quadrigemina will be seen the corpus geniculatum internum. It is a little oval eminence, very sharply defined, which lies on the side of the upper part of the mesencephalon under shelter of the pulvinar of the optic thalamus.

Connexions of the Brachia and the Origin of the Optic Tract.—It will now be seen that the brachia are intimately connected with the optic tract. The *inferior brachium* proceeding upwards from the lower quadrigeminal body advances towards the corpus geniculatum internum, and disappears from view under cover of this prominence. Upon the opposite side of this same geniculate body, the *mesial root* of origin of the *optic tract* is observed to arise, and the appearance is such that the dissector might very naturally conclude that the inferior brachium and this root of the optic tract are continuous. This, however, is not the case. The *superior brachium* is carried upwards and forwards between the overhanging pulvinar and the corpus geniculatum internum. It partly enters the corpus geniculatum externum, but a portion of it can easily be observed to be directly continuous with the *lateral root* of the optic tract.

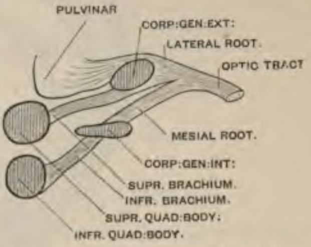

FIG. 196.—Diagram of the Roots of the Optic Tract.

The optic tract when traced backwards divides into a mesial and a lateral root. The *mesial root* enters the corpus geniculatum internum. The *lateral root* is partly continued into the superior brachium, whilst the remainder of its fibres enter the corpus geniculatum externum and the pulvinar. The superior quadrigeminal body, the corpus geniculatum externum, and the pulvinar constitute the *lower visual centres*.

Crura Cerebri. — The crura cerebri constitute the chief bulk of the mesencephalon. When viewed from below, they appear as two large rope-like strands, which emerge close together from the upper aspect of the pons Varolii, and diverge as they proceed upwards to enter the cerebrum. At the point where each crus disappears into the corresponding side of the hemisphere, it is embraced on its outer side by the optic tract.

The crus cerebri of each side consists of two parts, viz., a dorsal *tegmentum*, which is prolonged upwards to the region below the thalamus; and a ventral *crusta* or *pes*, which is carried upwards into the internal capsule on the outer side of the thalamus. When the base of the brain is examined, it is the crusta which is seen, and it is observed to be white in colour and streaked in the longitudinal direction. On the exterior of the mesencephalon, the separation between the two parts of the crus cerebri (*i.e.*, the tegmentum and the crusta) is indicated by an inner and an outer groove or sulcus. The inner or mesial sulcus is the deeper and more distinct. It looks into the interpeduncular space, and from it emerge the fascicles of the oculo-motor nerve. It consequently receives the name of the *sulcus oculomotorius.* The outer sulcus is termed the *sulcus lateralis.*

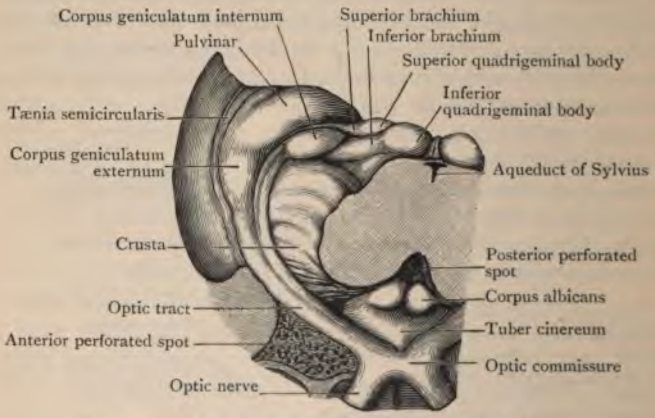
Corpus geniculatum internum
Superior brachium
Pulvinar
Inferior brachium
Superior quadrigeminal body
Inferior quadrigeminal body
Tænia semicircularis
Corpus geniculatum externum
Aqueduct of Sylvius
Crusta
Posterior perforated spot
Corpus albicans
Optic tract
Tuber cinereum
Anterior perforated spot
Optic commissure
Optic nerve

FIG. 197.—The Origin and Relations of the Optic Tract.
(Professor Thane, from *Quain's Anatomy.*)

Dissection.—The mesencephalon should now be divided transversely by one sweep of the knife at the level of the lower borders of the superior pair of corpora quadrigemina. By this proceeding, the cerebrum is separated from the parts below. A number of very important points can be made out on the cut surface of the mesencephalon.

Cut Surface of the Mesencephalon (Fig. 198).—Much nearer the dorsal than the ventral surface of the mesencephalon the transversely divided *aqueduct of Sylvius* may be seen. As already stated, this narrow passage leads from the fourth ventricle below, upwards through the mesencephalon to the third ventricle above. It is surrounded by a thick layer of grey matter, called the *Sylvian grey matter*, or the *central grey matter of the aqueduct.* In a fresh brain this is always very conspicuous, and in its midst are situated the nuclei of the oculo-motor and trochlear nerves, and the upper nucleus of the trigeminal nerve, although of course these cannot, except in very favourable circumstances, be detected by the naked eye. Below, this grey matter of the aqueduct is continuous with the grey matter spread out on the floor of the fourth ventricle; whilst above, it is continuous with the grey matter on the floor and sides of the third ventricle.

The division between the tegmentum and the crusta is rendered very evident by a conspicuous mass of dark pigmented matter which intervenes between them. This is termed the *substantia nigra*.

Substantia Nigra.—As seen in transverse section, the substantia nigra presents a somewhat crescentic outline. It is composed of a mass of grey matter in the midst of which are large numbers of pigmented nerve cells. The substantia nigra is in reality disposed in the form of a thick band interposed between the pedal and tegmental parts of the crus cerebri. Below, it begins at the upper border of the pons Varolii, and it extends upwards into the subthalamic region. The margins of this band of dark-coloured substance come to the surface at the oculo-motor and lateral sulci, and its inner part is traversed by the emerging nerve fibres of the oculo-motor nerve. The surface turned towards the tegmentum is concave and uniform; the opposite surface is convex, and rendered highly irregular by the presence of numerous slender prolongations of the substance into the crusta.

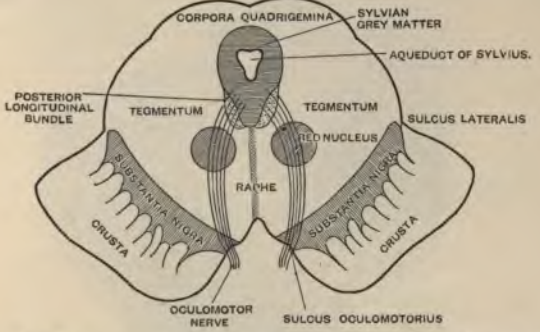
CORPORA QUADRIGEMINA
SYLVIAN GREY MATTER
AQUEDUCT OF SYLVIUS.
POSTERIOR LONGITUDINAL BUNDLE
TEGMENTUM
TEGMENTUM
SULCUS LATERALIS
RED NUCLEUS
SUBSTANTIA NIGRA
RAPHE
SUBSTANTIA NIGRA
CRUSTA
CRUSTA
OCULOMOTOR NERVE
SULCUS OCULOMOTORIUS

FIG. 198.—Diagrammatic view of the Cut Surface of the Mesencephalon when transversely divided.

Crusta.—The crusta is somewhat crescentic when seen in section, and stands quite apart from its fellow of the opposite side. It is composed of a compact mass of longitudinally directed nerve fibres which are carried upwards into the internal capsule. The middle third or more of each crusta is composed of the important *pyramidal tract* as it descends from the motor area of the cerebral cortex, but this is quite indistinguishable from the portions of the crusta which lie on either side of it.

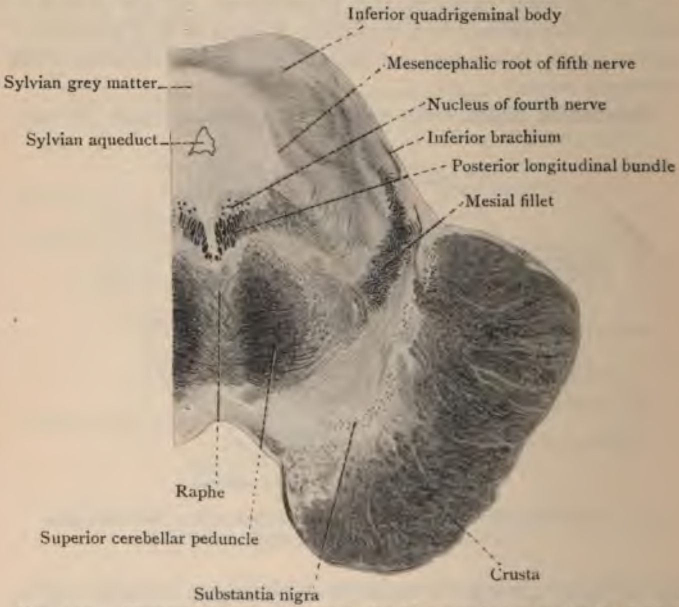
Inferior quadrigeminal body
Mesencephalic root of fifth nerve
Sylvian grey matter
Nucleus of fourth nerve
Sylvian aqueduct
Inferior brachium
Posterior longitudinal bundle
Mesial fillet
Raphe
Superior cerebellar peduncle
Crusta
Substantia nigra

FIG. 199.—Transverse section through the Mesencephalon at the level of the inferior quadrigeminal body: right side only reproduced. The drawing is taken from a Weigert-Pal specimen, and therefore the grey matter is pale and the strands of white matter are dark. The dark colour of the substantia nigra is not evident owing to the thinness of the section.

Tegmentum.—Unlike the crustæ, the tegmenta are directly continuous with each other in the mesial plane, a faint line, termed the median raphe, alone indicating their bilateral character. Towards the dorsum of the mesencephalon they are also fused with the bases of the corpora quadrigemina. *Their* lateral surfaces therefore are alone free.

The tegmentum is composed of an admixture of grey and white matter, constituting what is termed the *formatio reticularis.* The white matter is composed of fibres running both transversely and longitudinally. Certain of the longitudinal fibres are grouped together and form well-marked tracts, which, in a section through the mesencephalon of a fresh brain, can be detected by the naked eye. These tracts are: (1) the posterior longitudinal bundles; (2) the superior cerebellar peduncles or the brachia conjunctiva; (3) the fillet.

The *posterior longitudinal bundle* (Figs. 199 and 200) is a small compact tract which is placed upon the outer aspect of the lower portion of the central grey matter of the aqueduct.

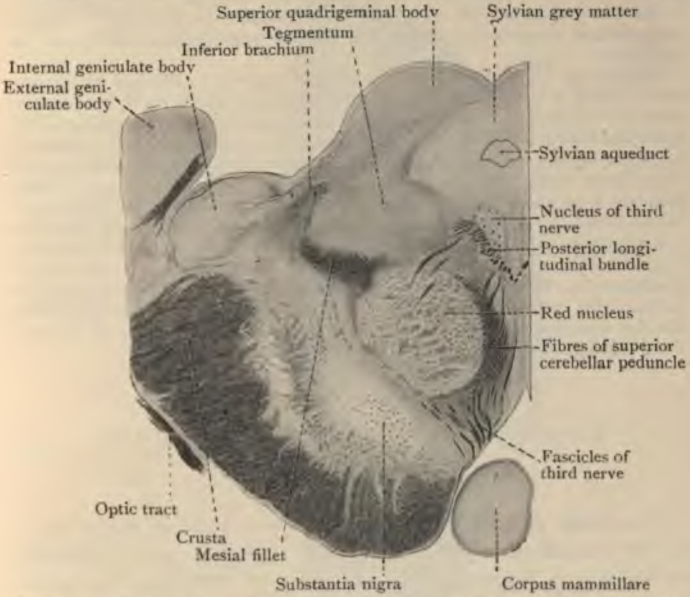
Superior quadrigeminal body
Sylvian grey matter
Tegmentum
Inferior brachium
Internal geniculate body
External geniculate body
Sylvian aqueduct
Nucleus of third nerve
Posterior longitudinal bundle
Red nucleus
Fibres of superior cerebellar peduncle
Fascicles of third nerve
Optic tract
Crusta
Mesial fillet
Substantia nigra
Corpus mammillare

FIG. 200.—Section through upper part of Mesencephalon at level of superior quadrigeminal body. The drawing is taken from a Weigert-Pal specimen. The dark colour of the substantia nigra is not evident owing to the thinness of the section.

The *superior cerebellar peduncles* are two large strands which are continued upwards from the cerebellum into the mesencephalon. By pulling back the margin of the cerebellum where it overlaps the lower quadrigeminal bodies, these peduncles will be seen on the surface as they converge in an upward direction. Stretching across the interval between them, and bringing them into continuity with each other, is a thin lamina called the valve of Vieussens. When the superior cerebellar peduncles reach the bases of the inferior quadrigeminal bodies, they sink into the substance of the mesencephalon, and in a transverse section through the lower part of this portion of the brain they may be seen as two white strands, semilunar in outline, and placed one on either side of the grey matter of the aqueduct. As they ascend, they gradually assume a deeper (*i.e.*, a more ventral) position in the tegmental part of the mesencephalon, and finally they decussate with each other across the mesial plane and proceed upwards.

The term *fillet* is given to two tracts presenting very different connexions. The *mesial fillet* (Figs. 199 and 200) is a sensory tract passing upwards to the optic thalamus. The *lateral fillet* belongs to the auditory apparatus, and is a part of a chain through which the cochlear nucleus establishes connexion with the inferior quadrigeminal body. The lateral fillet can be readily detected on the outer free surface of the lower part of the tegmentum in the form of some curved and usually conspicuous fibres which extend upwards and backwards to reach the inferior quadrigeminal body and its brachium.

Within the upper part of the tegmentum there is a collection of nuclear matter which is termed the *red tegmental nucleus*, from its ruddy appearance when seen in section. It is rod-like in form, and extends upwards into the tegmental region below the optic thalamus. In transverse section it presents a circular outline, and it is closely associated with the upward prolongation of the fibres of the superior cerebellar peduncle. The superior cerebellar peduncle is an efferent tract from the lateral hemisphere of the cerebellum, and its fibres end in the red nucleus and the pulvinar of the optic thalamus of the opposite side. The tegmentum of the crus cerebri may be considered to consist of two parts: viz., a *lower part*, which is subjacent to the inferior quadrigeminal bodies, and which is largely occupied by the decussation of the superior cerebellar peduncles; and an *upper part*, subjacent to the superior quadrigeminal bodies, which is traversed by the emerging bundles of the third nerve, and which contains the nucleus ruber.

BASAL GANGLIA OF THE CEREBRAL HEMISPHERES.

The basal ganglia of the cerebral hemispheres still require to be examined. These are the caudate and lenticular nuclei, which together form the corpus striatum; the claustrum; and the amygdaloid nucleus. With these it is necessary also to study the composition of the optic thalamus and the external and internal capsules.

Dissection.—The right and left portions of what remains of the cerebrum should be separated from each other by a mesial incision. On the left portion the sulci, and convolutions on the under or tentorial surface of the hemisphere, may be examined if this has not been done already on another specimen.

A series of sections should, in the next place, be made through both the right and left portions of the cerebrum, with the view of displaying the basal ganglia. On *the right side* remove a succession of thin slices by carrying a long knife in a horizontal direction through the parts which form and lie below the floor of the body of the lateral ventricle. It is not advisable to proceed farther down than the level of the anterior commissure.

On *the left side* of the brain a series of vertical-transverse or coronal sections should be made through the remaining portion of the cerebrum.

Begin by cutting off the portion in front of the head of the caudate nucleus, and then proceed steadily backwards until the hinder part of the optic thalamus is reached. One of the sections should be planned to pass through the anterior commissure.

Caudate Nucleus.—This nucleus has already been partly examined in connexion with the lateral ventricle, into the cavity of which it bulges. It is a pyriform highly arched mass of grey matter, which presents a thick swollen head or anterior extremity, and a long attenuated tail. The head projects into the anterior horn of the lateral ventricle, whilst its narrower part is prolonged outwards and backwards on the floor of the body of the ventricle, where it is separated from the optic thalamus by the tænia semicircularis. Finally, its tail turns downwards and then forwards into the descending

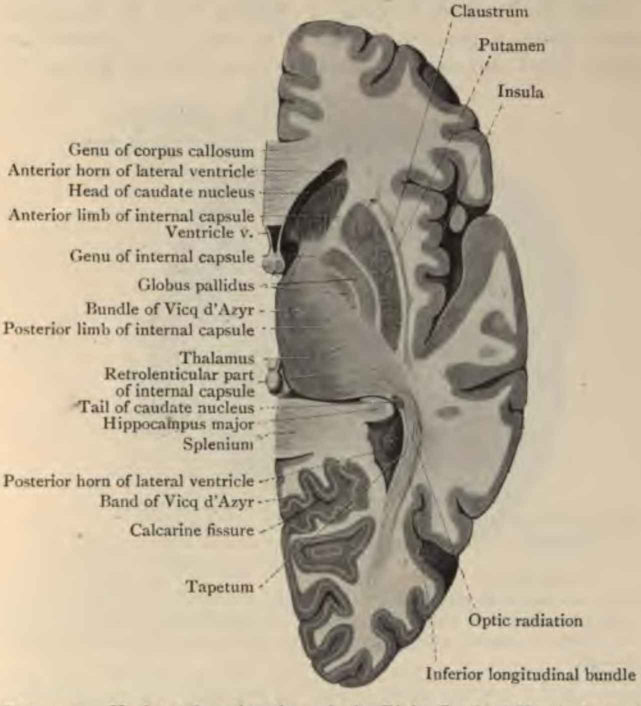
Claustrum
Putamen
Insula
Genu of corpus callosum
Anterior horn of lateral ventricle
Head of caudate nucleus
Anterior limb of internal capsule
Ventricle v.
Genu of internal capsule
Globus pallidus
Bundle of Vicq d'Azyr
Posterior limb of internal capsule
Thalamus
Retrolenticular part of internal capsule
Tail of caudate nucleus
Hippocampus major
Splenium
Posterior horn of lateral ventricle
Band of Vicq d'Azyr
Calcarine fissure
Tapetum
Optic radiation
Inferior longitudinal bundle

FIG. 201.—Horizontal section through the Right Cerebral Hemisphere at the level of the widest part of the lenticular nucleus.

horn of the lateral ventricle, on the roof of which it is prolonged until it finally joins the amygdaloid nucleus. The caudate nucleus, therefore, presents a free ventricular surface covered with ependyma, and a deep surface embedded in the substance of the cerebrum, and for the most part related to the internal capsule.

Owing to its arched form, it follows that in horizontal sections below a particular level it is cut at two points, and both the head and the tail must be looked for in the field of section (Fig. 201). In coronal sections behind the amygdaloid nucleus it is also divided at two places.

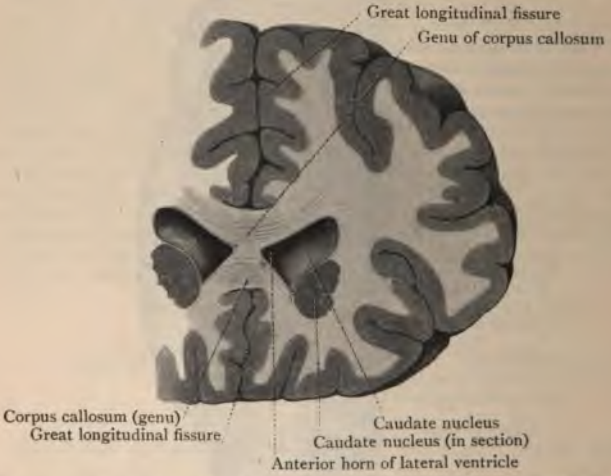
Great longitudinal fissure
Genu of corpus callosum
Corpus callosum (genu)
Great longitudinal fissure
Caudate nucleus
Caudate nucleus (in section)
Anterior horn of lateral ventricle

FIG. 202.—Coronal section through the Frontal Lobes of the Cerebrum. The posterior surface of the anterior part of the cerebrum is depicted so that the reader is looking into the anterior horns of the lateral ventricles from behind.

Lenticular Nucleus.—This mass of grey matter lies on the outer side of the caudate nucleus and the optic thalamus, and is for the most part completely embedded within the white medullary substance of the cerebral hemisphere. It does not occupy so much ground as the nucleus caudatus. Indeed, it presents a very close correspondence in point of extent with the island of Reil on the surface.

When seen in horizontal section (Fig. 201) it presents a shape similar to that of a biconvex lens. Its inner surface bulges more than the outer surface, and its point of highest convexity is placed opposite the tænia semicircularis or the interval between the caudate nucleus and the anterior end of the optic thalamus.

When seen in coronal section, the appearance presented by the lenticular nucleus differs very much in the different planes of section. Figure 203 represents a section through its anterior portion. Here it is semilunar or crescentic in outline. Further, it is intimately connected with the head of the caudate nucleus by bands of grey matter which pass between the two nuclei and break up the fore-part of the internal capsule. It is due to the ribbed or barred appearance which is presented by such a section as this that the term *corpus striatum* is given to the two nuclei.

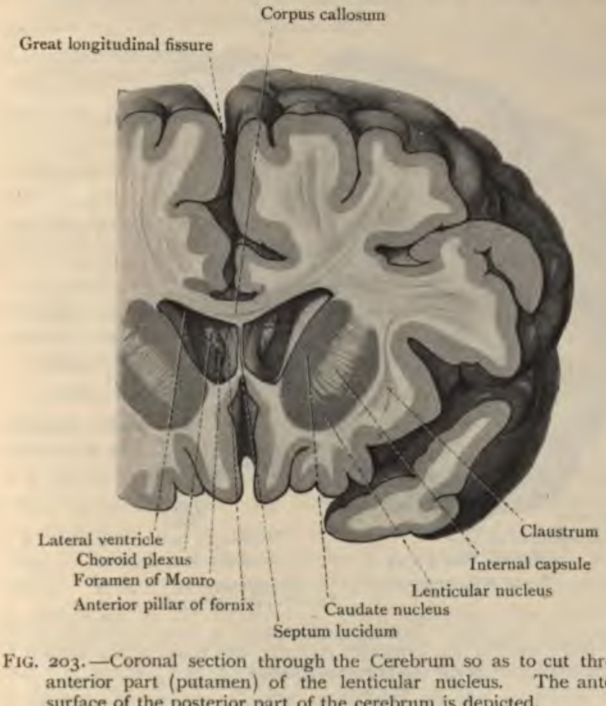
Corpus callosum
Great longitudinal fissure
Lateral ventricle
Choroid plexus
Foramen of Monro
Anterior pillar of fornix
Septum lucidum
Caudate nucleus
Lenticular nucleus
Internal capsule
Claustrum

FIG. 203.—Coronal section through the Cerebrum so as to cut through the anterior part (putamen) of the lenticular nucleus. The anterior cut surface of the posterior part of the cerebrum is depicted.

When the section is made in a plane farther back, the divided lenticular nucleus assumes an altogether different shape, and is seen to be completely cut off from the caudate nucleus by the internal capsule (Fig. 204). It is now triangular or wedge-shaped. Its base is turned towards the external capsule, the claustrum, and the island of Reil; its internal surface is applied to the internal capsule; whilst its inferior surface is directed downwards towards the base of the brain. But, further, two white laminæ are now evident, the *external* and the *internal medullary laminæ*, which traverse its substance and divide it into three zones. The outer, basal, and larger zone is termed the *putamen* (Fig. 204). It is darker in colour than the other two zones, and is traversed by fine radiating white streaks. The two inner zones are of a faint yellowish tint, and they together form what is termed the *globus pallidus* (Figs. 204 and 201). The putamen has a greater antero-posterior length than the globus pallidus. It

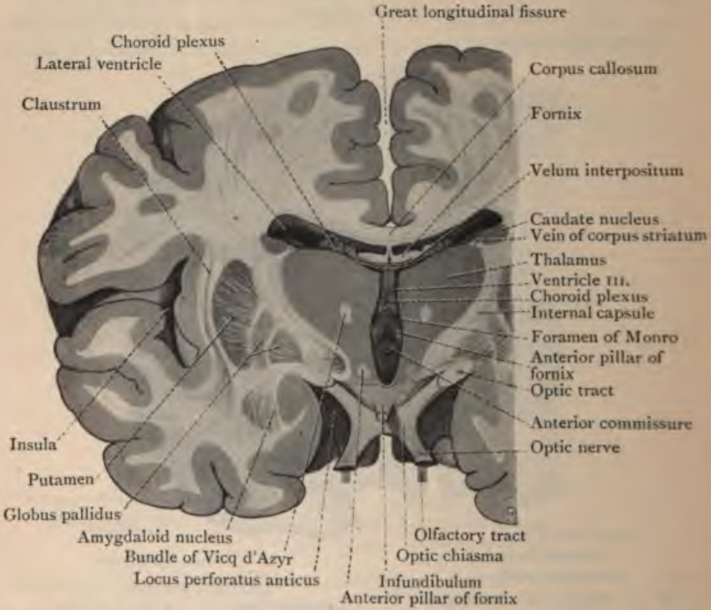
Great longitudinal fissure
Choroid plexus
Lateral ventricle
Claustrum
Corpus callosum
Fornix
Velum interpositum
Caudate nucleus
Vein of corpus striatum
Thalamus
Ventricle III.
Choroid plexus
Internal capsule
Foramen of Monro
Anterior pillar of fornix
Optic tract
Anterior commissure
Optic nerve
Insula
Putamen
Globus pallidus
Amygdaloid nucleus
Bundle of Vicq d'Azyr
Locus perforatus anticus
Olfactory tract
Optic chiasma
Infundibulum
Anterior pillar of fornix

FIG. 204.—Coronal section through the Cerebrum in such a plane as to cut the three parts of the lenticular nucleus; the posterior cut surface of the anterior part of the cerebrum is depicted.

follows from this that it alone is connected with the head of the caudate nucleus by the intervening bands of grey matter (Fig. 203).

The nucleus lenticularis comes to the surface at the anterior perforated spot, and a continuity between the grey matter forming it and the grey cortex of the brain is thus established.

Claustrum.—This is a thin plate of grey substance embedded in the white matter which intervenes between the lenticular nucleus and the grey cortex of the island of Reil (Figs. 201 and 204). Followed in an upward direction, it becomes gradually thinner until it ultimately appears, when seen in section, as an exceedingly delicate grey streak. As it is traced downwards, however, it thickens considerably, and at the base of the brain it comes to the surface at the anterior perforated spot, and becomes continuous with the grey matter of the cerebral cortex. Its extent corresponds very nearly with the area occupied by the island of Reil, and its surface towards this portion of the cerebral cortex shows ridges and depressions corresponding to the insular gyri and sulci.

Internal Capsule.—This term is applied to the broad band of white matter which intervenes between the lenticular nucleus on the outside, and the optic thalamus, tænia semicircularis, and caudate nucleus on the inner side. In front it is much broken up by the connecting bands of grey matter which pass between the head of the caudate nucleus and the fore-part of the putamen of the lenticular nucleus (Fig. 203); but behind this it forms a solid white mass of nerve fibres. When seen in horizontal section, the internal capsule is observed to be bent upon itself opposite the tænia semicircularis, or the interval between the caudate nucleus and the thalamus (Fig. 201). This bend, which points inwards, is called the *genu*. About one-third of the internal capsule lies in front of the genu, and this part is called the *anterior limb*; the remaining two-thirds, which lie behind the genu, constitute the *posterior limb*.

Connexions of the Internal Capsule.—The internal capsule is directly continuous below with the crusta of the cerebral peduncle. The dissector can easily satisfy himself in the specimens before him of this continuity; it is apparent in the more posterior of the coronal sections which he has made through the left portion of the cerebrum.

It has already been mentioned that the fibres which occupy the middle third or more of the crusta of the cerebral peduncle belong to the motor pyramidal tract. In the internal capsule these occupy the anterior half of the posterior limb, being thus placed immediately behind the genu. The fibres which constitute the inner third of the crusta come from the anterior limb of the internal capsule; whilst the fibres which form the outer third of the crusta are situated in the posterior limb.

When the fibres of the internal capsule are traced upwards, they are found to spread out in a radiating or fan-like manner so as to reach the various convolutions of the cerebral hemispheres. This arrangement is termed the *corona radiata*. As the fibres of the corona radiata are liberated from the internal capsule and spread out to reach their destinations, they are intersected by the system of fibres which comes from the corpus callosum, and which also radiate in every direction to gain the cortex of the cerebrum.

Nuclei of the Optic Thalamus.—When a horizontal section is made through the optic thalamus in a fresh brain, or in one which has been preserved by means of formalin or a chromic salt, the grey matter composing it is seen to be broken up into an external, an internal, and an anterior nucleus by thin white medullary laminæ.

External Capsule.—This term is applied to the thin stratum of white matter which intervenes between the lenticular nucleus and the claustrum (Figs. 201 and 204).

Dissection.—The bundle of Vicq d'Azyr and the anterior commissure should now be followed as far as this is possible in what remains of the right half of the cerebrum. In neither case is the dissection a difficult one.

By removing the remains of the lenticular nucleus the anterior commissure will be exposed in its course towards the temporal lobe. In the first instance, it passes transversely outwards through the lower part of the globus pallidus and below the putamen. It then bends suddenly backwards to reach the medullary centre of the temporal lobe, above the descending horn of the lateral ventricle. If the dissection be successfully accomplished, the anterior commissure will be seen to present a twisted or rope-like appearance.

The *bundle of Vicq d'Azyr* may be traced from the corpus mammillare upwards into the anterior nucleus of the optic thalamus by scraping away the grey matter on the side of the third ventricle. The continuity between the anterior pillar of the fornix and the corpus mammillare should at the same time be established. Within the corpus mammillare there is a nucleus of grey matter.

THE PARTS OF THE BRAIN WHICH LIE IN THE POSTERIOR CRANIAL FOSSA.

The parts which lie below the tentorium cerebelli in the posterior cranial fossa are the *medulla oblongata*, the *pons Varolii*, and the *cerebellum*. These are grouped around the *fourth ventricle* of the brain—a cavity which communicates below with the central canal of the spinal cord, and above with the aqueduct of Sylvius. Through the latter it establishes a connexion with the third ventricle of the brain.

Medulla Oblongata.—This is the continuation of the spinal cord into the brain. It is not more than one inch in length, and may be reckoned as beginning at the level of the foramen magnum. From this it proceeds upwards in a very nearly vertical direction, and ends at the lower border of the pons Varolii. At first its girth is similar to that of the cord, but it rapidly expands as it approaches the pons, and consequently it presents a more or less conical appearance. Its anterior surface lies behind the groove on the basilar portion of the occipital bone, whilst its posterior aspect is sunk into the vallecula of the cerebellum.

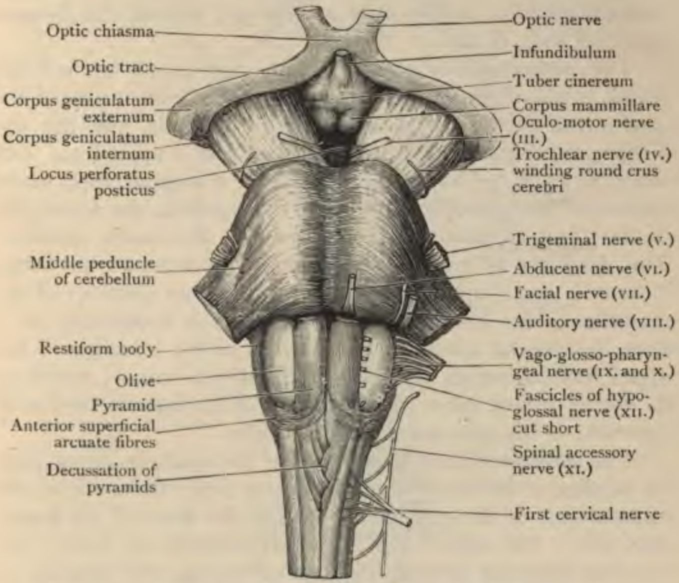
Optic chiasma
Optic tract
Corpus geniculatum externum
Corpus geniculatum internum
Locus perforatus posticus
Middle peduncle of cerebellum
Restiform body
Olive
Pyramid
Anterior superficial arcuate fibres
Decussation of pyramids
Optic nerve
Infundibulum
Tuber cinereum
Corpus mammillare
Oculo-motor nerve (III.)
Trochlear nerve (IV.) winding round crus cerebri
Trigeminal nerve (V.)
Abducent nerve (VI.)
Facial nerve (VII.)
Auditory nerve (VIII.)
Vago-glosso-pharyngeal nerve (IX. and X.)
Fascicles of hypoglossal nerve (XII.) cut short
Spinal accessory nerve (XI.)
First cervical nerve

FIG. 205.—Front view of the Medulla, Pons, and Mesencephalon of a full-time Fœtus.

The medulla oblongata is a bilateral structure, and this is evident even on an inspection of its exterior. The antero-median and postero-median grooves on the surface of the spinal cord are prolonged upwards on the anterior and posterior faces of the medulla.

The *antero-median groove*, as it passes from the cord on to the medulla, is interrupted at the level of the foramen magnum by several strands of fibres which cross the mesial plane from one side to the other. This intercrossing is termed the *decussation of the pyramids*. Above this level the furrow is carried upwards to the lower border of the pons. Here it expands slightly, and ends in a blind pit, termed the *foramen cæcum* of Vicq d'Azyr.

The *postero-median fissure* is only carried up for half the length of the medulla. At this point the central canal of the cord opens on the dorsal aspect of the medulla, and the lips of the postero-median fissure are thrust widely apart from each other, so as to constitute the limits of a triangular area, which forms on the posterior surface of the medulla, the lower part of the *fossa rhomboidalis*, or the floor of the fourth ventricle. The dissector is now in a position to understand the terms "closed" and "open" as applied to different portions of the medulla. The lower half of the medulla, containing as it does the central canal in its interior, is the *closed part*; the upper half (above the opening of the central canal), which by its dorsal surface forms the lower part of the floor of the fourth ventricle, is the *open part* of the medulla.

The surface of each lateral half of the medulla should now be studied. It is well, however, to defer for a little the examination of the medullary part of the floor of the fourth ventricle. The dissector has already noticed two linear rows of nerve fascicles issuing from and entering the medulla on each side. The *anterior row* consists of the roots of the hypoglossal and the uppermost part of the anterior root of the first cervical nerve. They continue upwards on the medulla in the line of the anterior nerve roots of the spinal cord, and they emerge along the bottom of a more or less distinct groove. The *posterior row* is formed of the nerve fascicles of the spinal accessory, vagus, and glosso-pharyngeal nerves, and they lie in series with the posterior roots of the spinal nerves.

By these two rows of nerve fascicles, each side of the medulla is divided into three districts, viz., an anterior, a lateral, and a posterior, similar to the surface areas of the *three* columns on the side of the cord. At first sight, indeed, they appear to be a direct continuation upwards of these portions of the cord; it is easily demonstrated, however, that this is not the case, and that the fibres in the three columns of the cord undergo a rearrangement as they are traced into the medulla.

Anterior Area of the Medulla—Pyramid.—The district between the antero-median furrow and the row of hypoglossal nerve fascicles issuing from the medulla receives the name of the pyramid. An inspection of the surface is almost sufficient to show that this is formed by a compact mass of longitudinally directed fibres. It expands somewhat, and assumes a more prominent appearance as it passes upwards, and, finally reaching the lower border of the pons Varolii, it becomes slightly constricted and disappears from view by plunging into that

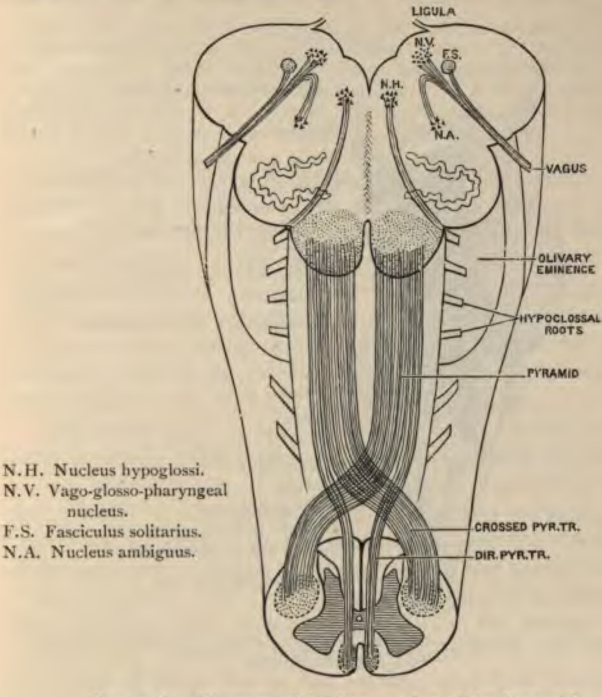
LIGULA
N.V.
F.S.
N.H.
N.A.
VAGUS
OLIVARY EMINENCE
HYPOCLOSSAL ROOTS
PYRAMID
CROSSED PYR.TR.
DIR.PYR.TR.
N.H. Nucleus hypoglossi.
N.V. Vago-glosso-pharyngeal nucleus.
F.S. Fasciculus solitarius.
N.A. Nucleus ambiguus.

FIG. 206.—Diagram of the Decussation of the Pyramids. (Modified from Van Gehuchten.)

structure. The pyramids are the great motor strands of the medulla.

Although the pyramid at first sight appears to be the continuation upwards of the anterior column of the cord, it contains within itself only a very small proportion of fibres which, lower down, occupy that column of the cord. This will be at once manifest if the *decussation of the pyramids* be examined. For this purpose introduce the back of the knife-blade into the antero-median furrow below the decussation, and on one side push forcibly outwards the anterior column of the cord. The pyramid will then be seen to divide at this level into two portions, viz., a small strand termed the *direct pyramidal tract*, which proceeds downwards into the anterior column of the cord, and takes up a position close to the antero-median furrow, and a much larger strand called the *crossed pyramidal tract*, which at this level is broken up into three or more coarse bundles which

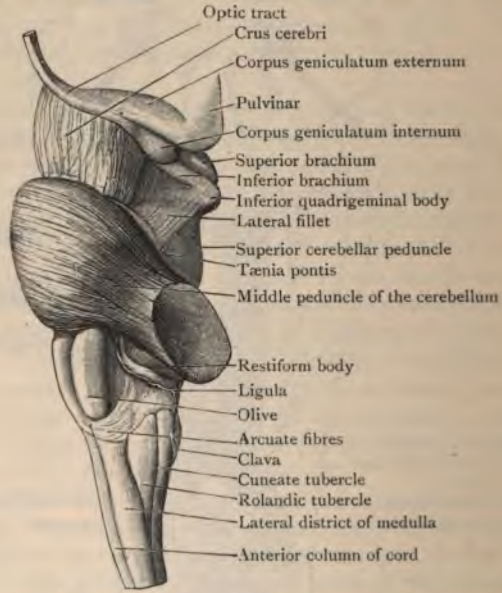
Optic tract
Crus cerebri
Corpus geniculatum externum
Pulvinar
Corpus geniculatum internum
Superior brachium
Inferior brachium
Inferior quadrigeminal body
Lateral fillet
Superior cerebellar peduncle
Tænia pontis
Middle peduncle of the cerebellum
Restiform body
Ligula
Olive
Arcuate fibres
Clava
Cuneate tubercle
Rolandic tubercle
Lateral district of medulla
Anterior column of cord

FIG. 207.—Lateral view of the Medulla, Pons, and Mesencephalon of a full-time Fœtus.

sink backwards, and, at the same time, cross the mesial plane to take up a position in the opposite lateral column of the cord, close to the posterior horn of grey matter. It is the intercrossing of the corresponding bundles of the crossed pyramidal tracts of opposite sides which produces this characteristic decussation.

But if the direct pyramidal tract in the anterior column of the cord is alone represented in the corresponding district of the medulla, it may be asked: What becomes of the larger lateral part of the anterior column of the spinal cord in the medulla? It is thrust aside by the decussating bundles of the crossed pyramidal tract, and thus comes to occupy a deep position in the medulla.

Lateral Area of the Medulla.—This is the district on the surface of the medulla which is included between the two rows of nerve roots, viz., the hypoglossal roots in front, and the root fascicles of the spinal accessory, vagus, and glossopharyngeal behind. It presents a very different appearance in its upper and lower parts. In its lower portion it appears to the eye as a continuation upwards of the lateral area of the cord: in its upper part is seen the striking oval prominence, which receives the name of the *olivary eminence.*

The lower part of this district, however, is very far from being an exact counterpart of the lateral column of the cord. As we have already observed, the large crossed pyramidal tract, which in the cord lies in the lateral column, is not present in this district of the medulla; above the decussation of the pyramids it forms the chief part of the pyramidal tract of the opposite side. Another small strand of fibres, the *direct cerebellar tract*, prolonged upwards in the lateral column of the cord, gradually leaves this portion of the medulla. This tract of fibres lies on the surface, and it is often visible to the naked eye as a white streak inclining obliquely backwards into the posterior district of the medulla to join its upper part, *i.e.*, the restiform body. The great majority of the remainder of the fibres which are prolonged upwards from the lateral column of the cord disappear from the surface at the lower border of the olivary eminence, by dipping into the substance of the medulla under cover of that projection. A narrow band, however, may be noticed to be carried upwards to the pons in the interval which exists between the posterior border of the olive and the roots of the vagus and glossopharyngeal nerves.

The *olivary eminence* is a smooth oval projection, which occupies the upper part of the lateral area of the medulla. Its long axis, which is vertical, is about half an inch long, and its upper end is separated from the lower border of the pons Varolii by an interval or groove.

Posterior Area of the Medulla.—In its lower half this district is bounded behind by the postero-median fissure, and in its upper half by the lateral margin of the medullary portion of the floor of the fourth ventricle. In front it is separated from the lateral area by the row of root-fascicles belonging to the spinal accessory, vagus, and glosso-pharyngeal nerves. As in the lateral area, we recognise a lower portion and an upper portion, which are quite distinct from each other.

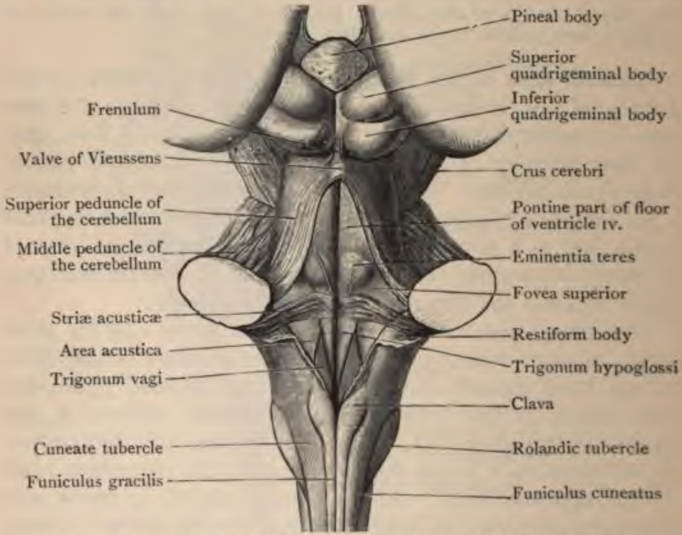
Pineal body
Superior quadrigeminal body
Inferior quadrigeminal body
Frenulum
Valve of Vieussens
Crus cerebri
Superior peduncle of the cerebellum
Pontine part of floor of ventricle IV.
Middle peduncle of the cerebellum
Eminentia teres
Fovea superior
Striæ acusticæ
Restiform body
Area acustica
Trigonum hypoglossi
Trigonum vagi
Clava
Cuneate tubercle
Rolandic tubercle
Funiculus gracilis
Funiculus cuneatus

FIG. 208.—Back view of the Medulla, Pons, and Mesencephalon of a full-time Fœtus.

The lower part of the posterior area corresponds more or less closely with the posterior columns of the cord. It will be remembered that in the cervical part of the cord the posterior columns are divided by a distinct septum of pia mater into an inner postero-median strand (column of Goll) and an outer postero-external strand (column of Burdach).

These are prolonged upwards into the medulla, and in the lower part of the posterior area they stand out distinctly, and are separated from each other by a continuation upwards from the cord of the paramedian groove. In the medulla these strands receive different names. The inner one is called the *funiculus gracilis*, whilst the outer one is designated the *funiculus cuneatus*. Each of these strands, when it reaches the lower part of the floor of the fourth ventricle, ends in a slightly expanded prominence. The swollen extremity of the funiculus gracilis is called the *clava*; it is thrust aside from its neighbour of the opposite side by the opening up of the medulla to form the floor of the fourth ventricle, and the central canal of the cord opens on the surface in the angle between the two clavæ. The thickened end of the cuneate funiculus receives the name of the *cuneate tubercle*, but it is only in the young brain that it is well marked.

In sections through this region of the medulla, it is seen that the prominences produced by these two strands and their enlarged extremities are in a great measure due to the presence of two elongated nuclei or collections of grey matter which lie subjacent to them, and which gradually increase as they are traced upwards. These are termed respectively the *gracile* and the *cuneate nuclei*, and it can be easily shown that as the grey matter increases in quantity the fibres of the two corresponding strands diminish in number. Indeed, it is doubtful if any of their fibres are prolonged upwards beyond the level of the nuclei.

But a third longitudinal elevation is also apparent in the lower part of the posterior area of the medulla. This is placed on the outer side of the funiculus cuneatus—between it and the posterior row of nerve roots—and it has no counterpart in the posterior column of the cord. It is called the *funiculus of Rolando*, because it is produced by the substantia gelatinosa Rolandi approaching the surface along this line. Extremely narrow below, the funiculus of Rolando widens somewhat as it is traced upwards, and finally ends in an expanded extremity called the *tubercle of Rolando*. The thin layer of fibres which appear on the surface of the tubercle and funiculus of Rolando and cover the substantia Rolandi in this position belong to the spinal root of the trigeminal nerve.

The *restiform body* forms the upper part of the posterior area. It lies between the lower part of the floor of the fourth ventricle and the roots of the vagus and glosso-pharyngeal nerves, and is thrust outwards by the opening up of the medulla. It is a large rope-like strand, which inclines upwards and outwards, and then finally takes a turn backwards, and enters the cerebellum, of which it constitutes *the inferior peduncle.* The restiform body, therefore, is to be regarded as the main connexion between the cerebellum above and the medulla and spinal cord below. At the same time, it must be understood that it is not formed of fibres which are prolonged into it from the funiculus gracilis and funiculus cuneatus of its own side. It is true that a surface inspection of the medulla might very naturally lead to this supposition, because there is no sharp line of demarcation marking it off from the tubercles of these strands.

The fibres which build up the restiform bodies come from several different sources. It will be sufficient to indicate the more important of these—(1) from the lateral column of the spinal cord through the *direct cerebellar tract*; (2) from the cerebellum as the cerebello-olivary fibres which go to the opposite inferior olivary nucleus; (3) from the cuneate and gracile nuclei of both sides in the form of the arcuate fibres.

Superficial Arcuate Fibres.—On the surface of the medulla, more particularly in the neighbourhood of the lower border of the olive, a number of curved bundles of fibres, termed the *anterior superficial arcuate fibres,* may be noticed. They vary greatly in number and in distinctness, and they are sometimes so numerous as to cover over almost entirely the olivary eminence. An attentive examination will show that they come to the surface in the antero-median groove between the pyramids, frequently in the groove between the pyramid and the olive, and sometimes also through the substance of the pyramids. But at whatever point they reach the surface, the majority have one destination, viz., the restiform body—a considerable part of which they form. They are derived from the cuneate and gracile nuclei of the opposite side.

The *posterior superficial arcuate fibres* arise in the cuneate and gracile nuclei, and enter the restiform body of the same side.

Dissection.—The pyramid of one side should now be carefully raised. When dislodged from its bed it should be gently pulled upwards towards the pons Varolii. In this way its entrance into the pons is brought very clearly into view, and further, numerous arcuate fibres will be seen running forwards upon the mesial aspect of the opposite pyramid to reach the surface.

Very little of the structure of the medulla can be learnt from specimens obtained in the dissecting-room. Further, it is not advisable to cut into the medulla at present, because the student has still to study that portion of its dorsal surface which forms the lower part of the floor of the fourth ventricle, and this cannot advantageously be done until the cerebellum has been examined. Still, it is convenient to say what little has to be said on the structure of the medulla at this stage.

Structure of the Medulla.—When transverse sections are made through the medulla at different levels, a faint line called the median raphe, and occupying the mesial plane, is seen to divide it into two exactly similar lateral portions. The raphe is formed by the close intersection of fibres running in different directions.

Each half of the medulla is composed of (*a*) strands of white matter; (*b*) grey matter, which is present both in the form of direct continuations into the medulla of portions of the grey matter of the cord, and also in the form of isolated clumps, which are not represented in the cord; and (*c*) the formatio reticularis, a substance which is composed of grey matter coarsely broken up by fibres which traverse it in different directions. The white matter, as in the cord, is for the most part disposed on the surface and the grey matter in the interior, but in the open part of the medulla the grey matter comes to the surface on its dorsal aspect, and is spread out over that area which forms the medullary portion of the floor of the fourth ventricle.

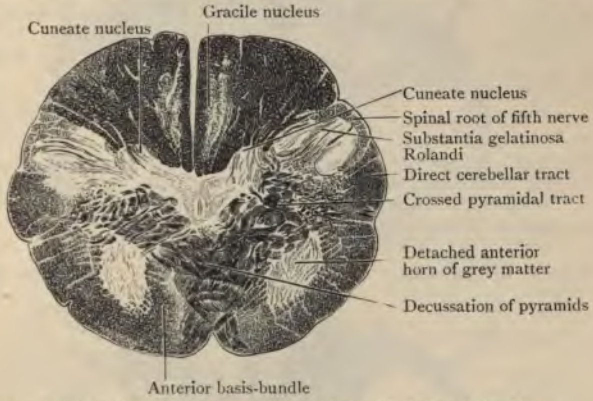

FIG. 209.—Section through the lower part of the Medulla of the Orang.

When the grey matter of the cord is traced up into the medulla, many striking changes in its arrangement become apparent. Owing to the increase in size of the large wedge-shaped gracile and cuneate funiculi, the posterior horns of grey matter become folded outwards, so that they soon assume a position at right angles to the mesial plane, and lie very nearly in the same transverse line. At the same time, the cuneate and gracile nuclear columns of grey matter which grow out from the basal portion of this horn and underlie the strands of the same name, begin to make their appearance. From the deep aspect of these nuclei, fibres, which take origin within them, stream forwards and inwards through the cervical portion of the posterior horn, so as to reach the raphe. The caput cornu is in this way cut off from the basal portion. The latter remains in close relation to the central canal, whilst the caput or substantia gelatinosa Rolandi is placed close to the surface, enlarges as it is traced upwards, and forms the prominence on the surface which has already been described as

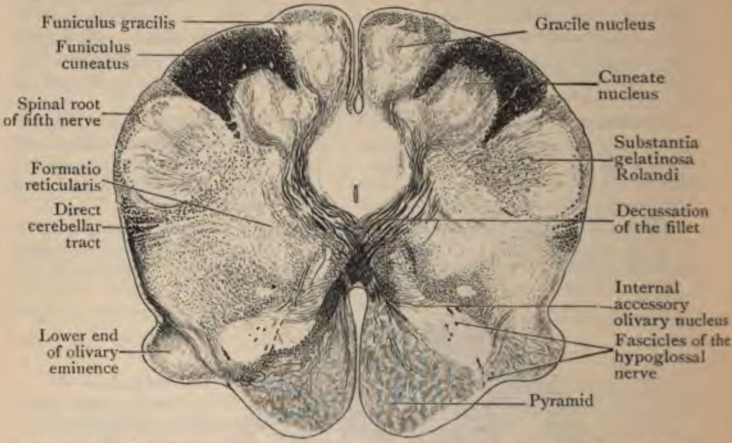
Funiculus gracilis
Funiculus cuneatus
Spinal root of fifth nerve
Formatio reticularis
Direct cerebellar tract
Lower end of olivary eminence
Gracile nucleus
Cuneate nucleus
Substantia gelatinosa Rolandi
Decussation of the fillet
Internal accessory olivary nucleus
Fascicles of the hypoglossal nerve
Pyramid

FIG. 210.—Transverse section through the closed part of the Medulla of a full-time Fœtus above the Decussation of the Pyramid, treated by the Weigert-Pal method. The grey matter is white, and the medullated strands of nerve fibres are rendered black.

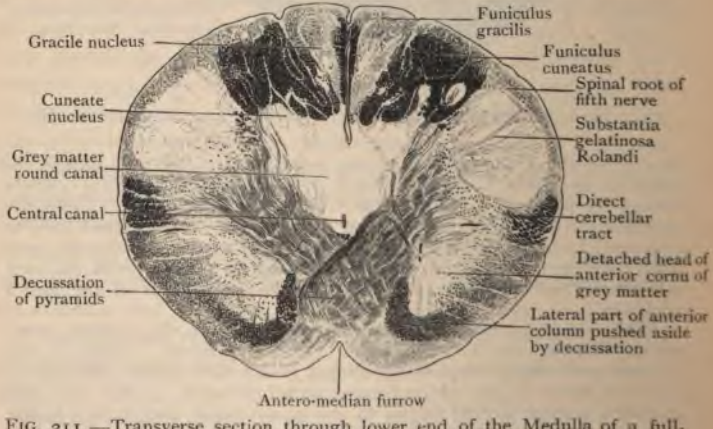
Funiculus gracilis
Gracile nucleus
Funiculus cuneatus
Spinal root of fifth nerve
Cuneate nucleus
Substantia gelatinosa Rolandi
Grey matter round canal
Direct cerebellar tract
Central canal
Detached head of anterior cornu of grey matter
Decussation of pyramids
Lateral part of anterior column pushed aside by decussation
Antero-median furrow

FIG. 211.—Transverse section through lower end of the Medulla of a full-time Fœtus, treated by the Weigert-Pal method. The grey matter is therefore bleached white; whilst the medullated tracts are black.

the funiculus and tubercle of Rolando. The fibres which have thus broken up the cervical part of the posterior horn, and which come from the cuneate and gracile nuclei, are termed the *internal* or *deep arcuate fibres.* They reach the raphe on the deep or dorsal aspect of the pyramids, and, crossing the mesial plane, they form a very complete decussation with the corresponding fibres of the opposite side, which is termed the *decussation of the fillet* or the *sensory decussation*, in contradistinction to the term *motor decussation*, which is sometimes applied to the crossing of the pyramids. As soon as they reach the opposite side of the medulla, these *internal* or *deep arcuate fibres* turn upwards and form a longitudinal tract, placed close to the raphe and on the dorsal aspect of the corresponding pyramid, which receives the name of the *fillet* or *lemniscus.*

The anterior horn of grey matter shares a like fate in the medulla, but at a lower level, at the hands of the crossed pyramidal tract. This great bundle, in passing from the pyramid into the lateral column of the cord of the opposite side, traverses the anterior horn so as to completely break up its intermediate part and separate its head from its basal portion. The further history of the detached head we need not trace, but it is well to observe that the basal part of the anterior horn of grey matter remains in position on the ventral and lateral aspect of the central canal.

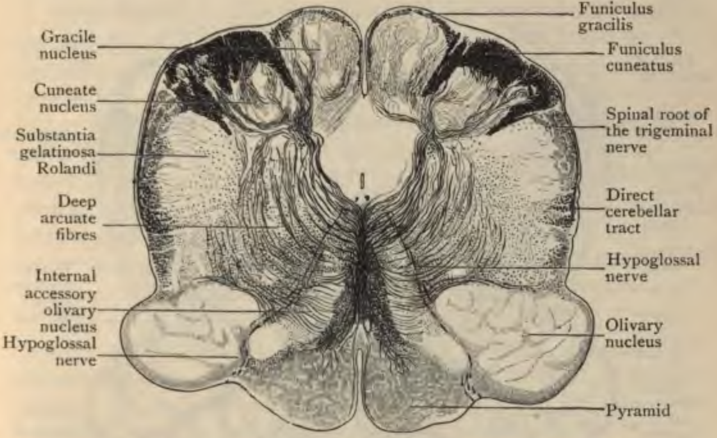
Funiculus gracilis
Gracile nucleus
Funiculus cuneatus
Cuneate nucleus
Spinal root of the trigeminal nerve
Substantia gelatinosa Rolandi
Deep arcuate fibres
Direct cerebellar tract
Hypoglossal nerve
Internal accessory olivary nucleus
Olivary nucleus
Hypoglossal nerve
Pyramid

FIG. 212.—Transverse section through the Medulla of new-born Child at the level of the lower part of the olivary eminence, stained by the Weigert-Pal method.

As we proceed up the closed part of the medulla, the central canal, surrounded by the basal portions of the two horns of grey matter, gradually inclines towards the dorsal aspect, until it finally opens on the surface. The grey matter which surrounds it is now spread out on the floor of the fourth ventricle, and in such a manner that the portion which corresponds to the basal part of the anterior horn of the cord is situated close to the mesial plane, whilst the part which represents the base of the posterior horn occupies a more lateral position. This is important, because the nucleus of origin of the hypoglossal nerve is placed in the mesial part of the floor, whilst the nucleus of termination of the vagus and glosso-pharyngeal nerves lies in the lateral part of the floor.

The most conspicuous of the isolated clumps of grey matter in the medulla are the olivary nucleus and the two accessory olivary nuclei. The *olivary nucleus* lies subjacent to the olivary eminence, and is a very conspicuous object in transverse sections through this region. In such cases it presents the appearance of a thick wavy or undulating line of grey matter folded upon itself so as to enclose a space filled with white matter and open towards the mesial plane. It is in reality a lamina arranged in a purse-like manner with its open mouth directed towards the raphe. The fibres which enter through its mouth constitute the *olivary peduncle*.

The *accessory olivary nuclei* are two band-like laminæ of grey matter, which are respectively placed on the dorsal and mesial aspects of the main nucleus. When seen in transverse section each of these nuclei presents a rod-like appearance (Fig. 213).

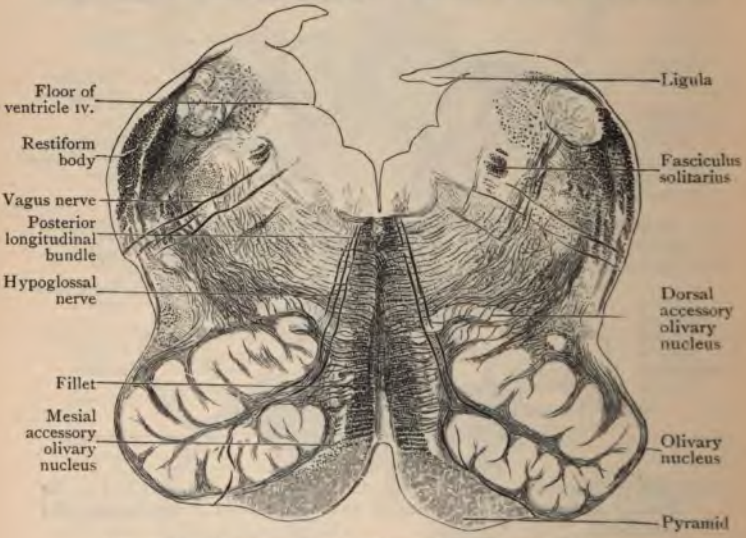
Floor of ventricle IV.
Restiform body
Vagus nerve
Posterior longitudinal bundle
Hypoglossal nerve
Fillet
Mesial accessory olivary nucleus
Ligula
Fasciculus solitarius
Dorsal accessory olivary nucleus
Olivary nucleus
Pyramid

FIG. 213.—Transverse section through the Medulla at the level of the mid-point of the olive (Weigert-Pal stain).

Behind, or deeper than, the olive and pyramid is the *formatio reticularis* of the medulla. It forms a large part of its substance, and is divided into a lateral and a mesial field by the nerve fascicles of the hypoglossal as they traverse the substance of the medulla to reach the surface. In the lateral portion, which lies behind the olive, there is a considerable quantity of grey matter, continuous with that of the cord, present in the reticular formation; it is therefore called the *formatio grisea*. In the mesial part, however, which lies behind the pyramid, the grey matter is extremely scanty, and the reticular matter here is termed the *formatio alba*.

The nerve fibres which traverse the formatio reticularis run both in the transverse and in the longitudinal direction. The *transverse fibres* are the *deep* or *internal arcuate fibres.* The *longitudinal fibres* are derived from different sources in the two fields. In the lateral part of the formation they represent the fibres of the lateral column (after the removal of the direct cerebellar and the crossed pyramidal tracts) which are continued up under cover of the olive. In the mesial part, or formatio alba, two longitudinal strands take origin, viz., the fillet and the posterior longitudinal bundle. Both lie close to the raphe. The *fillet* is placed immediately behind the pyramid, and is formed, as described, by the decussating internal arcuate fibres. The *posterior longitudinal bundle* takes form in the upper part of the medulla, immediately subjacent to the grey matter of the floor of the fourth ventricle. It is formed by longitudinal fibres of the formatio alba which come from the ground-bundle of the anterior column of the cord.

Pons Varolii.—The pons Varolii is the marked prominence on the base of the brain which is interposed between the medulla and the crura cerebri, and which lies in front of the cerebellum. It is convex from side to side, as well as from before backwards, and the transverse streaks on its surface show that superficially it is composed of transverse bundles of nerve fibres. On either side these transverse fibres collect themselves together so as to form a large compact strand which sinks in a backward and outward direction into the white matter of the corresponding hemisphere of the cerebellum. This strand is termed the *middle cerebellar peduncle.*

The ventral surface of the pons is in relation to the basilar process of the occipital bone and the dorsum sellæ of the sphenoid bone. It presents a mesial groove which gradually widens as it is traced upwards (Fig. 205). In this lies the basilar artery, but the groove is not caused by this vessel; it is due to the prominence which is produced on either side by the passage downwards through the pons of the bundles of fibres which form the pyramids of the medulla. Where the pons Varolii becomes the cerebellar peduncle the large trigeminal nerve will be seen emerging from its ventral surface, nearer its upper than its lower border.

With the exception of the restiform bodies, the whole of the medulla enters the lower aspect of the pons, and its constituent parts are carried upwards within it. The crura cerebri emerge from its upper aspect. The *dorsal surface* of the pons cannot be studied at present. It is turned towards the cerebellum, which hides it from view. It forms the upper part of the floor of the fourth ventricle.

Cerebellum.—The cerebellum is distinguished by the numerous parallel and more or less curved sulci which traverse its surface and give it a foliated appearance. As in the case of the cerebral hemispheres, the grey matter is spread over the entire surface, whilst the white matter forms in the interior a central core.

In the cerebellum we recognise a median portion, termed the *vermis*, and two lateral and much larger portions, called the *lateral hemispheres*. The distinction between these main subdivisions of the organ is not very evident from every point of view. In front, and also behind, there is a marked deficiency or notch (Fig. 214). The *posterior notch* is smaller and narrower than the anterior notch. It is bounded laterally by the hinder parts of the cerebellar hemispheres, whilst its bottom is formed by the median lobe or vermis. It is occupied by the falx cerebelli. The *anterior notch*, sometimes termed the *incisura semilunaris*, is much wider than the posterior notch. When viewed from above, it is seen to be occupied by the inferior pair of quadrigeminal bodies and the superior cerebellar peduncles. As in the case of the posterior notch, the sides are formed by the lateral hemispheres, and the bottom by the vermis.

On the *superior surface* of the cerebellum, there is little distinction to be noted between the median lobe and the upper surface of each lateral hemisphere. The median lobe or *superior vermis* forms a median elevation, from which the surface slopes gradually downwards on each side to the margin of the hemisphere. The vermiform elevation is highest in front, immediately behind the semilunar notch, and from this it gradually inclines downwards towards the posterior notch. It receives the name of the *monticulus cerebelli*. The folia on the surface of the vermis superior will be seen to be thicker and fewer in number than those on the upper surface of the lateral hemisphere. It is this that gives it the worm-like appearance from which its name is derived.

On the *inferior surface* of the cerebellum, the distinction between the three constituent parts of the organ is much better marked. On this aspect the lateral hemispheres, which are full, prominent, and convex, are separated by a deep, mesial hollow, which is continued forwards from the posterior notch. This hollow is termed the *vallecula cerebelli*, and in its fore-part is lodged the medulla oblongata. When the medulla is raised, and the lateral hemispheres pulled apart so as to expose the bottom of the vallecula, it will be seen that this is formed by the *vermis inferior*, and, further, that the latter is separated on each side from the corresponding lateral hemisphere by a distinct furrow, termed the *sulcus valleculæ.*

When the margin of the cerebellum, where it forms the bottom of the semilunar notch on the superior aspect of the organ, is gently pushed backwards, and the mesencephalon pulled forwards, two strands lying upon the dorsal aspect of the pons Varolii will be seen. These are the *superior cerebellar peduncles.* Emerging from the white matter of the cerebellum, they converge as they proceed upwards, and finally they disappear under the inferior quadrigeminal bodies. The thin lamina which is stretched across between them is the *valve of Vieussens*, or the *superior medullary velum.* It is continuous below with the white core of the cerebellum, and it forms the roof of the upper part of the fourth ventricle. From its dorsal surface, close to the inferior quadrigeminal body, the small trochlear or fourth cranial nerves emerge.

Certain of the fissures which traverse the surface of the cerebellum, deeper and longer than the others, map out districts which are termed lobes. The most conspicuous of all these clefts is the *great horizontal fissure.*

Great Horizontal Fissure of the Cerebellum.—The great horizontal fissure begins in front, and passes round the circumference of the cerebellum, cutting deeply into its outer and posterior margins. In front, its lips diverge from each other so as to enclose the large middle peduncle, where it passes into the interior of the cerebellum. The great horizontal fissure divides the organ into an upper and a lower part, which may be studied separately.

Lobes on the Upper Surface of the Cerebellum.—When examined from before backwards, the vermis superior presents the following subdivisions:—(1) the lingula; (2) the central lobule; (3) the culmen monticuli; (4) the clivus monticuli; (5) the folium cacuminis. With the exception of the lingula, each of these is continuous on either side with a corresponding district on the upper surface of the hemisphere, thereby forming a cerebellar lobe. Thus, the central lobule is prolonged outwards on each side in an expansion called the *ala*; the culmen constitutes a median connecting piece between the two *anterior crescentic lobules* of the hemispheres; the clivus stands in the same relation to the *posterior crescentic* *lobules*; and the folium cacuminis is the connecting band between the *postero-superior lobules* of the hemispheres.

Lingula.—The lingula can only be seen when the bottom of the semilunar notch is pushed backwards. It consists of four or five small folia continuous with the grey matter of the vermis superior, and prolonged forwards on the surface of the valve of Vieussens or superior medullary velum in the interval between the superior cerebellar peduncles.

Lobus Centralis with its Alæ.—The central lobule lies at the bottom of the semilunar notch, and is only seen to a very small extent on the upper surface of the organ. It is a little median mass which is prolonged outwards for a short distance round the semilunar notch in the form of two expansions, termed the *alæ*.

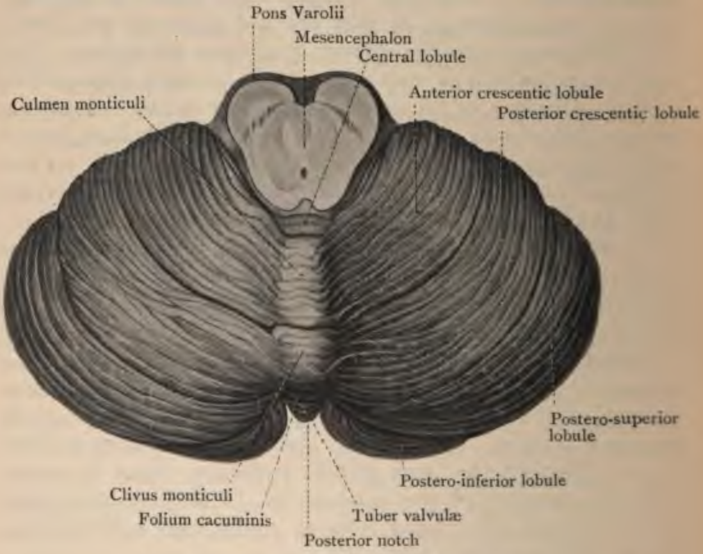
Pons Varolii
Mesencephalon
Central lobule
Culmen monticuli
Anterior crescentic lobule
Posterior crescentic lobule
Postero-superior lobule
Postero-inferior lobule
Clivus monticuli
Folium cacuminis
Tuber valvulæ
Posterior notch

FIG. 214.—Upper Surface of the Cerebellum.

Lobus Culminis.—The *culmen monticuli* constitutes the summit or highest part of the monticulus of the vermis superior. It is prolonged outwards on either side into the corresponding hemisphere as the *anterior crescentic lobule*. *This is* the most anterior subdivision on the upper surface of the hemisphere. The two anterior crescentic lobules, with the culmen monticuli, form the *lobus culminis cerebelli.*

Lobus Clivi.—The *clivus monticuli* lies behind the culmen, from which it is separated by a distinct fissure, and it forms the sloping part or descent of the monticulus of the vermis superior. On each side it is continuous with the *posterior crescentic lobule* of the lateral hemisphere, and the three parts are included under the one name of *lobus clivi.*

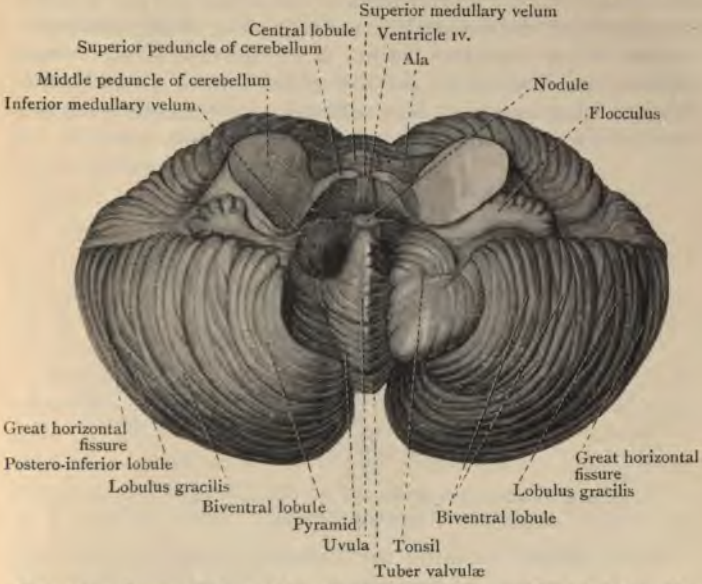
Superior medullary velum
Central lobule
Ventricle IV.
Superior peduncle of cerebellum
Ala
Middle peduncle of cerebellum
Nodule
Inferior medullary velum
Flocculus
Great horizontal fissure
Postero-inferior lobule
Lobulus gracilis
Biventral lobule
Pyramid
Uvula
Tonsil
Tuber valvulæ
Biventral lobule
Lobulus gracilis
Great horizontal fissure

FIG. 215.—Lower Surface of the Cerebellum. The tonsil on the right side has been removed so as to display the inferior medullary velum and the furrowed band.

The two crescentic lobules on the upper surface of the hemisphere are frequently described together as the *quadrate lobule.*

Lobus Cacuminis.—The *folium cacuminis* forms the most posterior part of the vermis superior, and it bounds the great horizontal fissure superiorly at the posterior notch. It is a single folium, the surface of which may be smooth or beset with rudimentary secondary folia. It is the connecting link between the two *postero-superior lobules* of the hemispheres—the three parts constituting the *lobus cacuminis.* As the folium cacuminis is traced outwards into the postero-superior lobule of the hemisphere, it is found to expand greatly. The result of this is that the postero-superior lobule on each side forms an extensive foliated district bounding the hinder part of the great horizontal fissure above.

Lobes on the under surface of the Cerebellum.—The connexion between the several parts of the vermis inferior and the corresponding districts on the under surface of the two hemispheres is not nearly so distinct as in the case of the vermis superior and the lobules on the upper surface of the hemispheres. A groove, the *sulcus valleculæ*, intervenes between the vermis inferior and the hemisphere on each side.

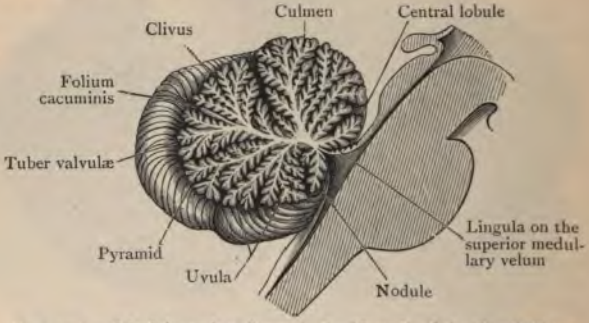

FIG. 216.—Mesial section through the Vermis of the Cerebellum. (From Gegenbaur.)

From behind forwards the following subdivisions of the vermis inferior may be recognised—(1) the tuber valvulæ, (2) the pyramid, (3) the uvula, and (4) the nodule.

On the under surface of the hemisphere there are five lobules mapped out by intervening fissures. These are—(1) the *flocculus*, a little lobule lying on the middle peduncle of the cerebellum; (2) the *biventral lobule*, which lies immediately behind the flocculus, and is partially divided into two parts by a fissure which traverses its surface; (3) the *tonsil* or *amygdala*, a rounded lobule, which bounds the vallecula on the inner side of the biventral lobule; (4) the *postero-inferior lobule*, placed behind the biventral lobule, and bounding the great horizontal fissure below.

These lobules of the hemispheres, with the corresponding portions of the vermis inferior, constitute the lobes on the under aspect of the cerebellum.

Lobus Noduli.—The lobus noduli comprises the nodule and the flocculus of either side with an exceedingly delicate connecting lamina of white matter, termed the *inferior medullary velum.*

The velum cannot be properly seen at present, but it will be exposed at a later stage of the dissection.

Lobus Uvulæ.—The uvula is a triangular elevation placed between the two tonsils. It is connected across the sulcus valleculæ with each tonsil by a low-lying ridge of grey matter scored by a few shallow furrows, and in consequence termed the *furrowed band.* The two tonsils and the uvula form the lobus uvulæ.

To see the furrowed band it will be necessary to remove the tonsil on one side.

Lobus Pyramidis.—The pyramid is connected with the biventral lobule on each side by a faint ridge which crosses the sulcus valleculæ. The term *lobus pyramidis* is given to the three lobules which are thus associated with each other.

Lobus Tuberis.—The *tuber valvulæ,* which forms the most posterior part of the vermis inferior, is composed of several folia, which run directly into the postero-inferior lobule on each side. The three parts of the *lobus tuberis* are thus linked together. The postero-inferior lobule is traversed by two, or it may be three, curved fissures. The most anterior of these cuts off a narrow, curved strip of cerebellar surface called the *lobulus gracilis.*

Dissection.—A mesial section should now be made through the vermis of the cerebellum and the two medullary vela into the cavity of the fourth ventricle. When the two parts of the cerebellum are drawn slightly asunder, a view of the fourth ventricle is obtained; further, the connexions of the two medullary vela and the arrangement of the peduncles of the cerebellum can be more clearly understood.

Arbor Vitæ Cerebelli.—The cut surface of the cerebellum presents a very characteristic appearance. The grey matter on the surface stands out distinctly from the white matter in the interior. Further, the complete manner in which the surface is cut up by the fissures and sulci into secondary and tertiary folia is seen. The central mass of white matter in the median lobe or worm is termed the *corpus trapezoides.* From this, main prolongations pass into the various lobules, and these give off branches so as to supply each folium with a central white stem or core. The term *arbor vitæ* is applied to the appearance which consequently results when a section is made through the cerebellum.

Cerebellar Peduncles.—These are three in number on each side—viz., the middle, the superior, and the inferior. They are all directly connected with the white medullary centre of the cerebellum, and are composed of fibres which emerge from or enter the white central substance of the organ.

The *middle peduncle* is much the largest of the three. It is formed by the transverse fibres of the pons, and it enters the cerebellar hemisphere on the outer side of the other two. The lips of the anterior part of the great horizontal fissure are separated widely from each other to give it admission. Within the cerebellar hemisphere its fibres are distributed in two great bundles. Of these, one, composed of the upper transverse fibres of the pons, radiates out in the lower part of the hemisphere; whilst the other, consisting of the lower transverse fibres of the pons, spreads out in the upper part of the hemisphere.

The *inferior peduncle* is simply the restiform body of the medulla. Leaving the back of the medulla it turns sharply backwards and enters the cerebellum between the other two peduncles.

The *superior peduncles* are composed of fibres which for the most part come from the corpus dentatum of the cerebellar hemisphere. As they issue from the cerebellum, each peduncle lies close to the inner side of the corresponding middle peduncle. They then proceed upwards towards the inferior pair of quadrigeminal bodies. At first they form the lateral boundaries of the upper part of the fourth ventricle, but they converge as they ascend on the dorsal aspect of the pons Varolii, so that ultimately they come to overhang that cavity and enter into the formation of its roof. They disappear under cover of the quadrigeminal bodies, and their course in the mesencephalon has already been described.

Medullary Vela.—The medullary vela are closely associated with the peduncles. They consist of two thin laminæ of white matter which are projected out from the white central core of the cerebellum. The *superior medullary velum*, or *valve of Vieussens*, stretches across the interval between the two superior cerebellar peduncles, with the inner margins of which it is directly continuous. It is triangular in form, and when traced downwards it is seen to be carried with the superior peduncles into the white matter of the cerebellum. Spread out on its dorsal surface is the tongue-shaped prolongation of grey matter from the cortex of the cerebellum, which is termed the *lingula*, and issuing from its substance close to the inferior quadrigeminal bodies are the two trochlear nerves.

The *inferior medullary velum* is somewhat more complicated in its connexions. It presents the same relation to the nodule that the superior velum presents to the lingula. It is a wide thin lamina of white matter—so thin that it is translucent—which is prolonged out from the white centre of the cerebellum above the nodule. From the nodule it stretches outwards to the flocculus, thereby bringing these two small portions of the cerebellum into association with each other. Where it issues from the white matter of the cerebellum, it might almost be said to be in contact with the superior medullary velum, but as the two laminæ are traced forwards they diverge from each other: the superior velum is carried upwards between the superior peduncles of the cerebellum, whilst the inferior medullary velum turns downwards round the nodule, and ends in a slightly thickened free crescentic edge. The cavity of the fourth ventricle is carried backwards between the two vela, which form a tent-like roof for it.

Fourth Ventricle.—This cavity is somewhat rhomboidal in form. Below, it tapers to a point and becomes continuous with the central canal of the cord; above, it narrows in a similar manner and is continued into the aqueduct of Sylvius. The posterior wall is called *the roof*. The anterior wall is termed *the floor*, and is formed by the dorsal surface of the medulla and of the pons. On either side a narrow pointed prolongation of the ventricular cavity is carried outwards from its widest part round the upper part of the corresponding restiform body. This is termed the *lateral recess* (Fig. 208, p. 526). Looking into the cavity between the two portions of the mesially divided cerebellum, the lateral recess is very apparent.

Floor of the Fourth Ventricle.—In its lower part the floor of the fourth ventricle is formed by the dorsal surface of the open part of the medulla, whilst in its upper part it is formed by the dorsal surface of the pons Varolii. The area thus constituted is distinctly lozenge-shaped, its widest part being opposite the inferior peduncles of the cerebellum. Further, it presents definite lateral boundaries. Thus, below, it is bounded on either side by the clava, the cuneate tubercle, and the restiform body; whilst above, the lateral limit is formed by the superior cerebellar peduncle. A thick layer of grey matter, continuous with that surrounding the central canal of the cord, is spread out like a carpet over the ventricular floor.

The floor of the fourth ventricle is divided into two symmetrical and lateral portions by a median groove. At the lower narrow end, between the two clavæ, it receives the name of the *calamus scriptorius*, from its fancied resemblance to the point of a pen. Crossing each half of the floor at its widest part are several transverse bundles of fibres termed the *striæ acusticæ*. They emerge from the mesial groove, and they are carried outwards over the restiform body. The striæ acusticæ divide each lateral half of the ventricular floor into an upper and a lower portion, which very nearly correspond to the subdivisions of this area formed by the medulla and the pons. On the lower medullary district a small triangular depression, placed immediately below the striæ acusticæ, catches the eye. This is termed the *fovea inferior*. It is shaped somewhat like an arrow-head. The apex or point looks towards the striæ, whilst the lateral angles of the base are prolonged downwards in the form of diverging grooves. Of these, the inner groove runs towards the opening of the central canal at the calamus scriptorius, whilst the outer groove runs towards the lateral boundary of the floor. In this manner the portion of the floor which lies below the striæ acusticæ is mapped out into three triangular areas. The mesial subdivision is slightly elevated, and is termed the *trigonum hypoglossi*, because subjacent to the inner part of this area is the nucleus of origin of the hypoglossal nerve. The intermediate area between the diverging grooves which proceed from the base of the fovea inferior is the *trigonum vagi*, so called because the vagus and glosso-pharyngeal nuclei lie subjacent to it. The external area is the *trigonum acustici*. The base of this area is directed upwards and runs continuously into an eminence, the *acustic tubercle*, over which the striæ acusticæ pass. Subjacent to this region of the floor of the ventricle lies the chief nucleus of termination of the vestibular part of the auditory nerve.

Separating the base of the trigonum vagi from the margin of the clava there is a narrow lanceolate strip of the floor of the fourth ventricle to which the name of *area postrema* has been given (Retzius).

On the part of the floor of the ventricle which lies above the striæ acusticæ, and which corresponds to the dorsal surface of the pons, there is also a slight depression. This is termed the *fovea superior*. Between it and the median groove there is a marked prominence, termed the *eminentia teres*. Inferiorly, this elevation passes downwards and becomes continuous with the trigonum hypoglossi; whilst above it is carried upwards towards the opening of the aqueduct of Sylvius. In both directions it becomes gradually less prominent, but still it forms a distinct elongated elevation which stretches along the whole length of the median groove. It is termed the *fasciculus teres*. Proceeding upwards from the fovea superior to the opening of the Sylvian aqueduct there is a shallow depression, termed the *locus cæruleus*. When the ependyma is scraped away from the surface of this part of the floor, some dark pigmented substance, termed the *substantia ferruginea*, will be exposed.

Roof of the Fourth Ventricle.—In its upper part the roof of the fourth ventricle is formed by the superior medullary velum as it stretches across between the two superior cerebellar peduncles, and also to some extent by the approximation of these peduncles themselves as they approach the mesencephalon.

In its lower part the roof of the ventricle is exceedingly thin, and is not all formed of nervous matter. The inferior medullary velum enters into its formation, and where this fails the epithelial lining of the cavity, supported by pia mater, is carried downwards towards the lower lateral boundaries of the ventricle. At the lowest part of the calamus scriptorius, and also along each lateral boundary, a thin lamina of white matter is carried for a short distance over the epithelial roof. The small lamina at the calamus scriptorius overhangs the opening of the central canal, and is termed the *obex*. The lamina in relation to the lateral boundary of the ventricle is more extensive, and is called the *ligula*. It begins on the clava, and passes upwards along the cuneate tubercle to the restiform body. On the surface of this it turns outwards so as to bound the lateral recess below, and in some cases it may be seen to become continuous round the extremity of the lateral recess with the inferior medullary velum.

A short distance above the calamus scriptorius there is an aperture in the epithelial roof of the fourth ventricle, by means of which the cavity of the ventricle communicates with the subarachnoid space. This opening is termed the *foramen of Magendie.* There is also an aperture of a similar character in the epithelial roof of each lateral recess.

Two *choroid plexuses,* one on either side of the mesial plane, invaginate the roof of the fourth ventricle in such a way that they appear to lie within the cavity. Offshoots from these likewise intrude into the lateral recesses.

Dissection.—The dissector should now introduce his fingers into the great horizontal fissure of the right half of the cerebellum, and gently tear the upper part of this side of the organ away from the lower part. By this proceeding the manner in which the peduncles enter the white medullary centre, and also to some extent the general distribution of their fibres, will be seen.

Both portions of the cerebellum should, in the next place, be removed by cutting through the peduncles at the points where they enter the central white matter. A horizontal section may then be made through the left half of the organ, rather nearer its upper surface than its lower surface. This will reveal the corpus dentatum.

Corpus Dentatum of the Cerebellum.—This is a collection of grey matter, embedded in the white medullary centre of the lateral hemisphere of the cerebellum, which presents an appearance very similar to that of the inferior olivary nucleus of the medulla. It is a thin lamina of grey matter, which appears on section as a wavy line folded upon itself, so as to form a crumpled grey capsule with an open mouth towards the mesial plane. The greater number of the fibres which build up the superior cerebellar peduncle issue from its mouth.

There are other smaller isolated nuclei of grey matter in the white medullary centre of the cerebellum, but these cannot, as a rule, be demonstrated in a specimen obtained in the dissecting-room. They lie nearer the mesial plane.

Dissection.—A series of transverse sections should now be made through the pons Varolii and the medulla, in order that something of their internal structure may be learned. The structure of the medulla is briefly described at p. 529.

Internal Structure of the Pons Varolii.—When transverse sections are made through the pons, it is seen to consist of two well-defined parts, viz., a ventral and a dorsal. Broadly speaking, the *ventral part* corresponds to the pyramidal parts of the medulla, and the pedal parts of the crura cerebri; whilst the *dorsal part* corresponds to the formatio reticularis of the medulla and the tegmental part of the crura cerebri.

The *ventral part of the pons* is the larger of the two subdivisions. It is composed of a large number of transverse bundles of fibres, through the midst of which coarse longitudinal bundles of fibres proceed downwards from the crustæ of the crura cerebri to form in the medulla the two pyramids. Scattered amongst these transverse and longitudinal bundles of fibres, and filling up the interstices between them, we have a large amount of grey matter termed the *nuclei pontis*. Of the transverse fibres two distinct sets may be recognised, viz., the superficial transverse fibres, through the midst of which the pyramidal bundles are prolonged, and a deeper set termed the corpus trapezoides. The *superficial transverse fibres* traverse the entire thickness of the ventral part of the pons, and on each side pass into the corresponding middle peduncle of the cerebellum. The *trapezial fibres* lie behind the pyramidal bundles in the boundary line between the dorsal and ventral parts of the pons, but encroaching considerably into the ground of the former. They are only seen in the lower part of the pons, and they pass into the lateral fillet. They take origin in the terminal nucleus of the cochlear division of the auditory nerve.

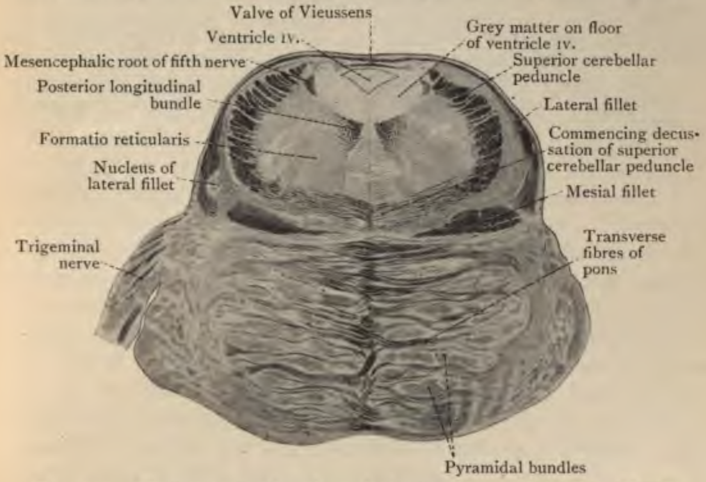
Valve of Vieussens
Ventricle IV.
Grey matter on floor of ventricle IV.
Mesencephalic root of fifth nerve
Superior cerebellar peduncle
Posterior longitudinal bundle
Lateral fillet
Formatio reticularis
Commencing decussation of superior cerebellar peduncle
Nucleus of lateral fillet
Mesial fillet
Trigeminal nerve
Transverse fibres of pons
Pyramidal bundles

FIG. 217.—Transverse section through the upper part of the Pons Varolii of the Orang.

The *dorsal or tegmental part of the pons* is for the most part formed of a prolongation upwards of the formatio reticularis of the medulla. Superiorly it is carried into the tegmental parts of the crura cerebri. It is divided into two lateral parts by a mesial raphe continuous below with the raphe of the medulla and above with the raphe of the tegmental part of the mesencephalon, whilst over its dorsal surface is spread a thick layer of grey matter which belongs to the upper part of the floor of the fourth ventricle. In transverse sections through the pons a dark spot in the outer part of this indicates the position of the *substantia ferruginea*.

Four strands of longitudinal fibres are seen on each side in transverse sections through the dorsal part of the pons. These are (1) the mesial fillet, (2) the lateral fillet, (3) the posterior longitudinal bundle, and (4) the superior cerebellar peduncle.

The *mesial fillet* assumes in the pons a ribbon-shaped form. It is placed between the ventral part of the pons and the formatio reticularis of the dorsal part.

The *lateral fillet*, largely composed of fibres derived directly or indirectly from the corpus trapezoides, is seen in the upper part of the pons sweeping round the outside of the superior cerebellar peduncle so as to gain the surface.

The *posterior longitudinal bundle* is much more distinct than it is lower down in the medulla. It has separated itself more completely from the longitudinal fibres of the formatio reticularis, and it is now seen close to the mesial plane immediately subjacent to the grey matter of the floor of the fourth ventricle.

The *superior cerebellar peduncle* in transverse sections presents a semilunar outline. It occupies a lateral position in the dorsal part of the pons, and gradually sinks deeply into its substance, although it does not become completely submerged until it reaches the mesencephalon.

The *superior olive* is a small isolated clump of grey matter which is embedded in the dorsal part of the pons in the path of the corpus trapezoides.

THE AUDITORY APPARATUS.

THE organ of hearing admits of a very natural subdivision into three parts, viz., the external, the middle, and the internal ear. The *external ear* consists of the pinna and the external auditory meatus. The pinna collects the waves of sound, and is, comparatively speaking, of subsidiary importance in man, although it is highly developed and of considerable service in some of the lower animals. The external auditory meatus is a passage which leads inwards to the membrana tympani from the bottom of the concha. The *middle ear* is a narrow chamber termed the tympanum or drum of the ear. It is interposed between the external auditory passage and the internal ear or labyrinth, and its outer wall is formed by the membrana tympani. Stretching across the cavity of the tympanum, from its outer to its inner wall, there is a chain of three minute bones called the auditory ossicles. The *internal ear* or labyrinth is the essential part of the organ. It consists of a complicated system of cavities in the densest part of the petrous portion of the temporal bone. These cavities contain fluid called perilymph, and also a membranous counterpart of the bony chambers called the membranous labyrinth. Within the latter there is fluid termed endolymph.

Dissection.—In a temporal bone to which the pinna is still attached the squamous portion should be removed by a horizontal saw-cut at the level of the posterior root of the zygoma. With the chisel and bone forceps the roof and anterior wall of the auditory passage should then be taken away piecemeal, until a good view is obtained of the outer surface of the membrana tympani.

Meatus Auditorius Externus.—The pinna has already been described (p. 269). The external meatus, measured from the bottom of the concha to the membrana tympani, is about one inch in length. It consists of an outer part composed of cartilage and fibrous tissue and about 8 mm. long; and an inner part, about 16 mm. long, the walls of which are formed of bone. It does not present a uniform diameter, being widest at its entrance and narrowest at a point in its osseous portion called the *isthmus*, which is situated about 5 mm. from the membrana tympani. As the tube passes from the surface inwards it describes a gentle sigmoid curve, but its general direction is inwards with a slight inclination forwards. The skin lining the cartilaginous portion is abundantly furnished with ceruminous glands, and is also provided with outwardly-directed hairs, which tend to prevent the entrance of dust. The cutaneous lining of the osseous part, which is thin and tightly adherent to the subjacent periosteum, is destitute of hairs, and glands are for the most part absent. The cutaneous lining of the meatus is continued in the form of an exceedingly delicate layer over the outer surface of the membrana tympani.

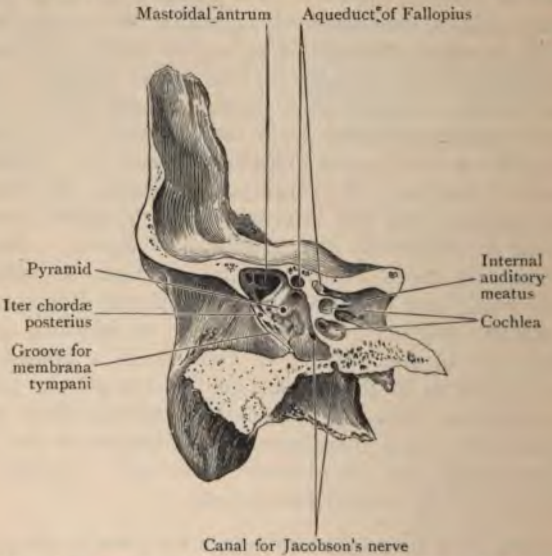
Mastoidal antrum
Aqueduct of Fallopius
Pyramid
Iter chordæ posterius
Groove for membrana tympani
Internal auditory meatus
Cochlea
Canal for Jacobson's nerve

FIG. 218.—Coronal section of the Right Temporal Bone passing through the external and the internal auditory meatuses.

If the subject is slightly decomposed the cuticular lining of the meatus may be drawn out entire, like the finger of a glove, and the epidermal covering of the membrana tympani is thus demonstrated.

Dissection.—The tympanic cavity can be most conveniently opened for inspection by the removal of its roof. The roof is formed by a thin scale of bone (tegmen tympani) which extends beyond the limits of the tympanum and covers in the canal for the tensor tympani in front and the mastoidal antrum behind. An opening should be made through the tegmen tympani, immediately external to the elevation formed by the superior semicircular canal, and about three-eighths of an inch in front of the superior border of the petrous bone. This will open into the mastoidal antrum. The opening can then be cautiously enlarged with the chisel and bone forceps until the whole of the tegmen tympani is picked away piecemeal. The roof of the internal auditory meatus should also be carefully removed with mallet and chisel. The mastoidal antrum, the tympanum with its contents, the osseous portion of the Eustachian tube, the tensor tympani muscle, and the auditory and facial nerves are now displayed.

Mastoidal Antrum.—This is a recess or air-chamber in the petrous bone with a diameter of about one-third of an inch. It is placed behind the tympanum, and communicates by a relatively large opening with the upper part of that cavity. From the surface of the skull it lies at a depth of about half an inch, but in the child it is placed much more superficially. It is lined by mucous membrane, which is continuous with the lining membrane of the tympanum. The mastoid process is also occupied by air-cells. These communicate with the mastoidal antrum, and are lined with mucous membrane. The extent to which the mastoid process is hollowed out by air-cells varies much in different individuals. In all cases it is necessary to bear in mind the intimate relation of the mastoid process and its contained cells with the lateral sinus.

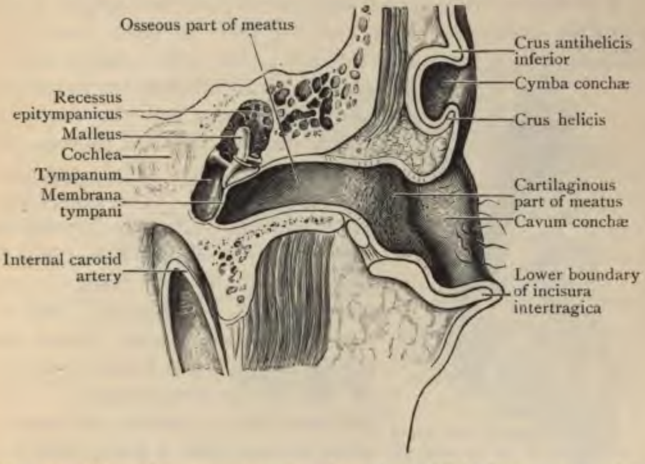
Osseous part of meatus
Recessus epitympanicus
Malleus
Cochlea
Tympanum
Membrana tympani
Internal carotid artery
Crus antihelicis inferior
Cymba conchæ
Crus helicis
Cartilaginous part of meatus
Cavum conchæ
Lower boundary of incisura intertragica

FIG. 219.—Vertical transverse section through the Right Ear: anterior half of section viewed from behind. (Howden.)

Tympanic Cavity or Middle Ear.—The tympanum is a small chamber filled with air, which is placed between the bottom of the meatus externus and the internal ear or labyrinth. Behind, it communicates by a relatively large orifice with the mastoidal antrum and air-cells; whilst in front, the Eustachian tube opens into it and brings it into connexion with the cavity of the pharynx. It contains the chain of auditory ossicles which cross from its outer to its inner wall, and it is lined by delicate mucous membrane.

The vertical depth and the antero-posterior length of the tympanic cavity is about half an inch in each case. Its width, however, from side to side, is not more than a sixth of an inch, and as both its outer and inner walls bulge into the cavity, its width in the centre is thereby still further reduced. The tympanic cavity consists of (1) an upper part, which extends upwards beyond the level of the membrana tympani, and to which the term *recessus epitympanicus* is applied; and (2) the *tympanum proper*, which lies below, immediately to the inner side of the membrana tympani. The tympanic cavity presents for examination a roof and a floor, with four walls, viz., anterior, posterior, external, and internal.

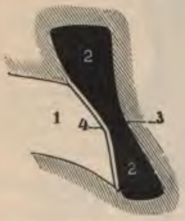

FIG. 220.—Schematic vertical section through the Tympanum. (From Testut.)

1. External meatus.
2. Tympanic cavity (the upper "2" is in the recessus epitympanicus).
3. Promontory or inner wall.
4. Membrana tympani.

The *roof* is composed of a thin plate of bone termed the *tegmen tympani*. This separates it from the cranial cavity. In chronic inflammatory conditions of the middle ear an extension of the inflammatory process to the meninges of the brain must always be guarded against.

The *floor* is narrow, and is also formed by a thin osseous lamina, which is interposed between the tympanum and the jugular fossa, which lodges the internal jugular vein. An extension of an inflammatory condition of the middle ear in this direction, therefore, might lead to thrombosis.

The *posterior wall* presents, in its upper part, the opening which leads from the recessus epitympanicus into the mastoidal antrum, and below this, close to the inner wall, a small hollow conical projection termed *the pyramid*. This is perforated on its summit, and the aperture leads into a canal which curves backwards and then downwards until it finally opens into the lower part of the last stage of the Fallopian aqueduct. This curved canal lodges the stapedius muscle, the delicate tendon of which enters the tympanic cavity through the aperture on the summit of the pyramid. On the outer side of the pyramid is the aperture on the posterior wall through which the chorda tympani nerve enters the tympanum.

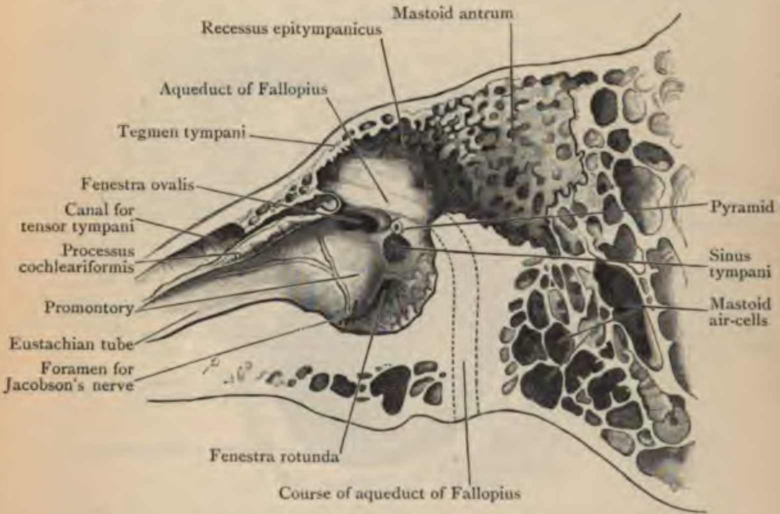
Mastoid antrum
Recessus epitympanicus
Aqueduct of Fallopius
Tegmen tympani
Fenestra ovalis
Canal for tensor tympani
Processus cochleariformis
Promontory
Eustachian tube
Foramen for Jacobson's nerve
Pyramid
Sinus tympani
Mastoid air-cells
Fenestra rotunda
Course of aqueduct of Fallopius

FIG. 221.—Section through the Left Temporal Bone showing the Inner Wall of the Tympanic Cavity. (Howden.)

The *anterior wall* is narrow, because the inner and outer walls become somewhat approximated to each other as they are traced forwards. To a large extent this wall is deficient, as here the tympanic cavity is continued directly into the osseous part of the Eustachian tube. Above this aperture is the canal, in which is lodged the tensor tympani muscle.

The *inner wall* which intervenes between the tympanum and the labyrinth presents certain important points for study. The greater part of this wall bulges outwards into the cavity in the form of a very evident elevation termed the *promontory*. Above the hinder part of the promontory there is an oval foramen, the long axis of which is directed from before backwards. This is the *fenestra ovalis*, an opening into the vestibular part of the labyrinth, and it is closed in the recent state by the footpiece of the stapes, the innermost of the auditory ossicles. The pyramid on the posterior wall will be seen to lie immediately behind the fenestra ovalis. Above the fenestra ovalis, in the angle formed by the meeting of the roof and inner wall of the tympanum, and therefore in the recessus epitympanicus, a ridge, arching from before backwards, will be seen. This is produced by the aqueduct of Fallopius bulging into the tympanum. Its wall is very thin, and allows the white colour of the facial nerve which is contained within the canal to be readily seen. In front of this ridge, in the upper part of the inner wall of the tympanum, is the *processus cochleariformis* supporting the *tensor tympani muscle*. The processus cochleariformis forms a trough or gutter of bone which runs backwards towards the anterior end of the *fenestra ovalis*, immediately above which it terminates. Here it makes a sharp bend, which almost surrounds the tendon of the tensor tympani, and forms a pulley upon which

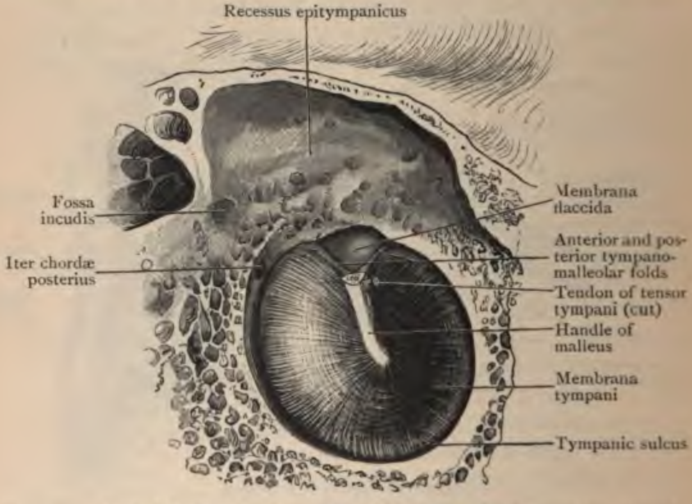
Recessus epitympanicus
Fossa incudis
Iter chordæ posterius
Membrana flaccida
Anterior and posterior tympano-malleolar folds
Tendon of tensor tympani (cut)
Handle of malleus
Membrana tympani
Tympanic sulcus

FIG. 222.—Left Membrana Tympani and Recessus Epitympanicus viewed from within. The neck and head of the malleus have been removed to show the membrana flaccida. (Howden.)

the tendon plays. Below the hinder end of the promontory is the *fenestra rotunda*, an aperture which, in the macerated bone, leads into the cavity of the cochlea, but which in the recent state is closed by a membrane which is stretched across it, and receives the name of the *secondary membrane of the tympanum.*

The *outer wall* of the tympanic cavity is formed for the most part by the membrana tympani.

Membrana Tympani.—The membrana tympani is an elliptical disc of membrane which is stretched across the bottom of the meatus auditorius externus, so as to form the greater part of the outer wall of the tympanum. It is placed very obliquely; its lower and its fore borders both incline inwards.

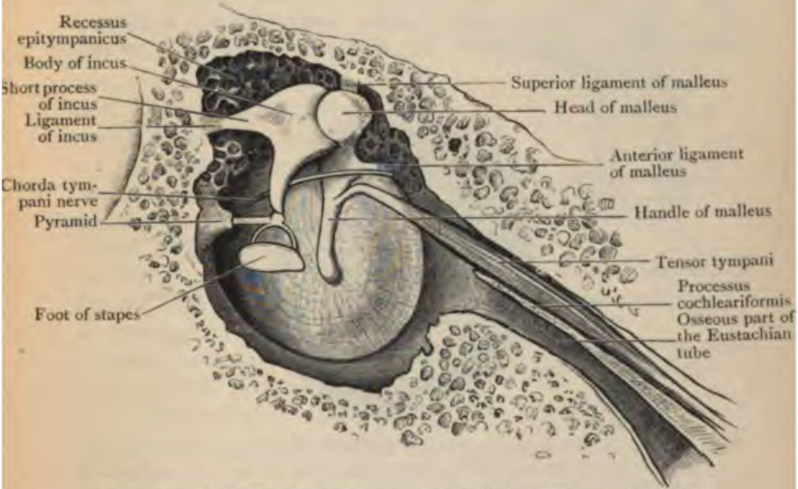
Recessus epitympanicus
Body of incus
Short process of incus
Ligament of incus
Chorda tympani nerve
Pyramid
Foot of stapes
Superior ligament of malleus
Head of malleus
Anterior ligament of malleus
Handle of malleus
Tensor tympani
Processus cochleariformis
Osseous part of the Eustachian tube

FIG. 223.—Left Membrana Tympani and Chain of Tympanic Ossicles seen from the inner aspect. (Howden.)

Its mode of attachment around the bottom of the meatus is deserving of some attention. Here, there is a ring-like ridge of bone very distinctly grooved which forms, as it were, a frame in which the membrane is set. But this ridge is deficient above, and at this point there is a deep notch (the notch of Rivinus) between the extremities of the bony ridge. This notch is occupied by a portion of the membrane which is not so dense in its texture (seeing that the fibrous layer is absent), and not so tightly stretched; consequently it receives the name of the *membrana flaccida* (Shrapnell's membrane). The edge of that part of the membrane which is fixed in the circular bony groove (sulcus tympanicus) is thickened, and at the notch of Rivinus it is carried down in front and behind the membrana flaccida in the form of two bands, called respectively the *anterior* and *posterior tympano-malleolar folds*.

The membrana tympani is composed of three layers—viz., an outside cuticular layer, an intermediate fibrous lamina, and an inside mucous layer. The handle of the malleus is intimately connected with the fibrous layer, and is covered over by the mucous layer. It draws the membrane inwards towards the tympanic cavity, so that the outer surface is deeply concave. The deepest point of this concavity corresponds with the flattened extremity of the handle of the malleus, and is termed the *umbo* or *umbilicus*.

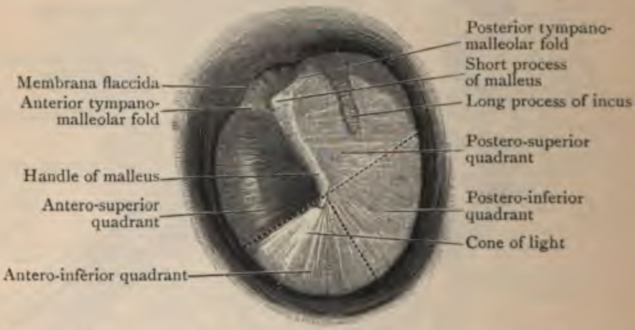
Posterior tympano-malleolar fold
Short process of malleus
Membrana flaccida
Anterior tympano-malleolar fold
Long process of incus
Postero-superior quadrant
Handle of malleus
Antero-superior quadrant
Postero-inferior quadrant
Cone of light
Antero-inferior quadrant

FIG. 224.—Left Tympanic Membrane as viewed from the external auditory meatus during an otoscopic examination. The dotted lines indicate the manner in which the tympanic membrane is subdivided arbitrarily into four areas or quadrants. (Howden.)

In examining the living ear with a speculum, the surface of the membrane appears highly polished, and a cone of light extends downwards and forwards from the tip of the handle of the malleus. A pair of striæ (Prussak's striæ), which correspond to the anterior and posterior tympano-malleolar folds, extend from the processus brevis of the malleus to the margins of the notch of Rivinus, and thus map out Shrapnell's membrane. The long process of the incus can be faintly seen through the membrana tympani, parallel to and behind the handle of the malleus.

Tympanic Mucous Membrane.—The tympanum is lined throughout with a thin mucous membrane which is continuous with the mucous membrane of the pharynx. As already mentioned, it forms the innermost layer of the membrana tympani, and is prolonged backwards into the mastoidal antrum and air-cells. It also covers the ossicles and invests the tendons of the stapedius and tensor tympani muscles.

Auditory Ossicles.—These are termed the malleus, the incus, and the stapes.

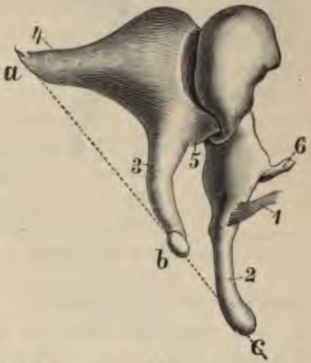

FIG. 225.—Left Malleus and Incus. (After Helmholtz.)

1. Tendon of tensor tympani.
2. Handle of the malleus.
3. Long process of the incus.
4. Short process of the incus.
6. Processus gracilis of the malleus. The straight line *a b c* connects the extremities of the two processes of the incus with the extremity of the manubrium of the malleus.

The *malleus* presents a head, a neck, a manubrium or handle, and two processes termed respectively the processus brevis and the processus gracilis. The *head* is large and rounded. It is directed upwards, and lies above the level of the membrana tympani, in the recessus epitympanicus and close to the roof of the tympanum. On its posterior aspect there is a notch-like articular surface directed backwards for articulation with the body of the incus. The *manubrium* is attached to the fibrous layer of the membrana tympani. The *processus brevis* is a stunted projection which springs from the root of the manubrium. It is directed outwards, and abuts against the membrana tympani immediately below the membrana flaccida. The *processus gracilis* is a slender spicule of bone which is directed forwards, and enters the Glaserian fissure. It almost invariably breaks in detaching the malleus from the adult skull, but it can be easily preserved in the skull of an infant.

The *incus* is shaped somewhat like a bicuspid tooth in which the fangs are very divergent. It presents a body with a long and a short process. The *body* is provided with an articular surface which looks forwards and articulates with the head of the malleus. The *short process* is directed backwards, and its extremity is attached by ligaments to the posterior wall of the tympanum near the opening into the mastoidal antrum. The *long process* proceeds downwards and inwards in a direction nearly parallel to that of the manubrium of the malleus, but internal, and on a plane posterior to that process. On its inferior extremity, which is bent inwards, there is a small knob of bone called the *processus lenticularis.* This articulates with the head of the stapes.

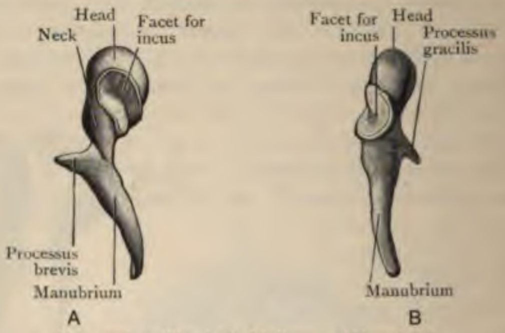
Head
Neck
Facet for incus
Processus brevis
Manubrium
A
Facet for incus
Head
Processus gracilis
Manubrium
B

FIG. 226.—The Left Malleus. (Howden.)

A. Viewed from behind. B. Viewed from inner side.

The malleus and incus move together on an axis which is formed by the processus gracilis of the malleus and the short process of the incus, The articular surfaces of the two bones are provided with peculiar catch-teeth which interlock when the bones are performing their ordinary movements. When, however, force is applied to the inner surface of

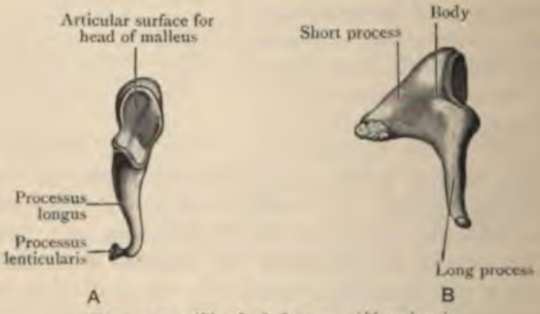
Articular surface for head of malleus
Processus longus
Processus lenticularis
A
Body
Short process
Long process
B

FIG. 227.—The Left Incus. (Howden.)

A. Seen from the front. B. Seen from the inner side.

the membrana tympani, as, for instance, when the tympanum is inflated through the Eustachian tube, the malleo-incudal joint gapes and the malleus moves by itself. Traction upon the attachments of the stapes, through the incus, is thus obviated.

The *stapes* is shaped like a stirrup, and presents a head or outer extremity separated by a slightly constricted neck from two limbs or crura which join an internal plate or footpiece. The *head* is excavated by an articular cup for the processus lenticularis of the incus. The *crura* are grooved longitudinally on their concave sides (sulcus stapedis). The posterior crus is more sharply curved than the anterior crus. The *footpiece* fits into the fenestra ovalis and corresponds in its outline with this aperture. Its lower border is straight, whilst its upper border is curved.

Ligaments of the Auditory Ossicles.—In addition to the delicate capsular ligaments which surround the joints between the auditory ossicles, there are certain bands which connect the bones to the walls of the tympanum and serve to restrain their movements.

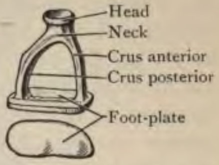

FIG. 228.—Left Stapes. (Howden.)

In connexion with the malleus there are (1) an *anterior ligament* which passes from its fore-part at the root of the processus gracilis to the anterior wall of the tympanum in the neighbourhood of the Glaserian fissure; (2) an *external ligament* which extends from its short process to the margin of the notch of Rivinus; and (3) a *superior ligament* which connects the head with the roof of the tympanum.

The *ligament of the incus* binds the extremity of its short process to the posterior wall of the tympanum, whilst the *annular ligament of the stapes* connects the margin of its footpiece to the circumference of the fenestra ovalis.

Tympanic Muscles.—These are two in number, viz., the stapedius inserted into the neck of the stapes, and the tensor tympani inserted into the malleus.

The *stapedius* occupies the interior of the pyramid and the canal which curves downwards from it. The delicate tendon of the stapedius enters the tympanum through the aperture on the summit of the pyramid, and is inserted into the posterior aspect of the neck of the stapes. It is supplied by a branch from the *facial nerve.*

The *tensor tympani* arises from the upper part of the cartilage of the Eustachian tube and from the contiguous part of the great wing of the sphenoid. From this it passes backwards and outwards upon the processus cochleariformis and above the osseous part of the Eustachian tube. In the tympanic cavity the tendon turns sharply round the extremity of the processus cochleariformis and proceeds directly outwards, from the inner towards the outer wall of the tympanum to its insertion into the upper part of the manubrium of the malleus on its internal aspect. The tensor tympani receives its nerve of supply from the *otic ganglion*.

Chorda Tympani Nerve.—The chorda tympani, which traverses the tympanic cavity in close relation to the upper part of the membrana tympani, is described on p. 407.

Tympanic Plexus.—This has also been previously described on p. 314.

Eustachian Tube.—The Eustachian tube is the passage which brings the tympanic cavity into communication with the pharynx, and through which air reaches the tympanic cavity and the mastoidal cells. It consists of an osseous and a cartilaginous portion. The *osseous portion* is about half an inch in length. It is widest at its entrance into the tympanum, and narrowest at its other end. The *cartilaginous portion* is about an inch in length, and has been already described on p. 381.

Dissection.—A good deal of the anatomy of the internal ear may be learned by chiselling away the surrounding bone from the harder walls of the different cavities which form the osseous labyrinth. When this is being done the bone must be held in a vice. The dissection can best be carried out in the petrous bones of an eighth-month or a full-time fœtus.

Various sections should also be made through the macerated bone.

Internal Ear or Labyrinth.—The labyrinth consists of an intricate system of cavities in the petrous part of the temporal bone. They contain hollow membranous structures in connexion with which the filaments of the auditory nerve end. We therefore recognise an osseous and a membranous labyrinth.

The *osseous labyrinth* is composed of an intermediate chamber termed the vestibule, behind which are placed the three semicircular canals, whilst in front is the cochlea. All these cavities communicate with each other. The corresponding membranous parts do not completely occupy the osseous chambers, and the intervening space is filled with a fluid termed the *perilymph*. The *membranous labyrinth* also contains a fluid which receives the name of *endolymph*.

Vestibule.—The vestibule is a small ovoidal bony chamber, the antero-posterior diameter of which is about the sixth of an inch in length. It is situated between the inner wall of the tympanum and the bottom of the internal auditory meatus.

Into the back-part of the vestibule the three semicircular canals open by *five round apertures*; whilst in its lower and fore part is the opening of the *scala vestibuli* of the cochlea.

On the *outer wall* is the fenestra ovalis, which is closed in the recent state by the delicate periosteal lining of the chamber and the footpiece of the stapes. When these parts are removed, the vestibule communicates directly through this aperture with the tympanum. On the anterior part of the *inner wall* of the vestibule there is a circular depression, termed the *fovea hemispherica*, which is bounded behind by a vertical ridge, called the *crista vestibuli*. The bottom of the fovea hemispherica is perforated by some minute holes which give admission to filaments from the auditory nerve. On the *roof* of the vestibule another depression, named the *fovea hemi-elliptica*, may be seen. It is placed behind the crista vestibuli.

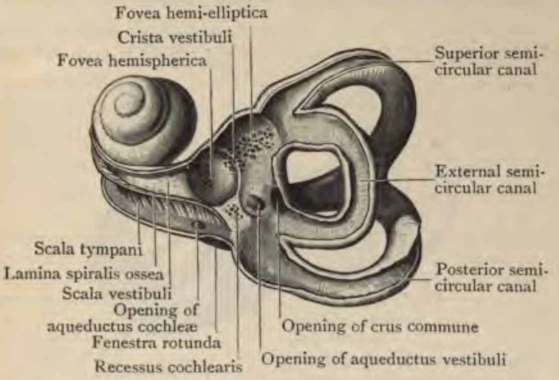
Fovea hemi-elliptica
Crista vestibuli
Fovea hemispherica
Superior semi-circular canal
External semi-circular canal
Scala tympani
Lamina spiralis ossea
Scala vestibuli
Opening of aqueductus cochleæ
Fenestra rotunda
Recessus cochlearis
Posterior semi-circular canal
Opening of crus commune
Opening of aqueductus vestibuli

FIG. 229.—Interior of the Left Bony Labyrinth viewed from the outer aspect. (Howden.)

A small aperture placed on the posterior part of the inner wall likewise deserves mention. It is the mouth of the *aqueductus vestibuli*—a small canal which leads backwards to the posterior surface of the petrous bone, where it opens under the dura mater.

Semicircular Canals.—These are three bony canals or tubes placed behind the vestibule. They are bent upon themselves, so that each forms considerably more than half a circle, and they occupy planes at right angles to each other like three faces of a cube. They are termed superior, posterior, and external, and they open into the back part of the vestibule by five round orifices, the number of openings being thus reduced through the adjoining extremities of the superior and posterior canals becoming fused together so as to present a common canal (crus commune) with a single orifice. One extremity of each canal where it joins the vestibule becomes expanded into what is termed its *ampulla*. There are thus three ampullated ends.

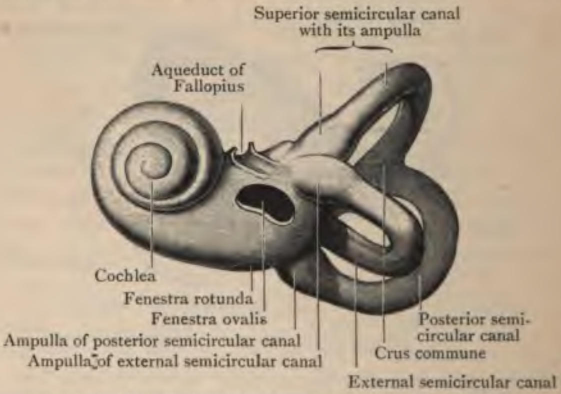
Superior semicircular canal with its ampulla
Aqueduct of Fallopius
Cochlea
Fenestra rotunda
Fenestra ovalis
Ampulla of posterior semicircular canal
Ampulla of external semicircular canal
Posterior semicircular canal
Crus commune
External semicircular canal

FIG. 230.—Left Bony Labyrinth viewed from outer side. (Howden.)

The *superior semicircular canal* forms the highest part of the labyrinth, and gives rise to a smooth elevation on the anterior surface of the petrous bone, immediately in front of its superior border. It is vertical, and placed somewhat transversely to the long axis of the petrous bone. The *posterior semicircular canal*, which is the longest of the three tubes, is also vertical, and lies in a plane parallel to the posterior surface of the petrous bone. The *external semicircular canal* is the shortest of the tubes, and occupies a horizontal plane.

Cochlea.—The cochlea is a tapering tube which is coiled spirally for two turns and a half around a central pillar, termed the *modiolus*. The appearance produced is somewhat similar to that of a spiral shell. The cochlea lies in front of the vestibule, with its base directed towards the bottom of the internal auditory meatus; whilst its apex looks forwards and outwards, and comes into close relation with the canal for the tensor tympani muscle.

The cochlear tube rapidly diminishes in diameter as it is traced towards the apex of the cochlea, and its closed extremity is termed the *cupola*. The first turn which it takes around the modiolus produces the bulging on the inner wall of the tympanum, which has been described under the name of the promontory.

The *modiolus* is thick at the base, but rapidly tapers towards the apex. Its base abuts against the bottom of the internal auditory meatus. It forms the inner wall of the cochlear tube, and winding spirally round it like the thread of a screw is a thin lamina of bone, termed the *lamina spiralis*, which partially subdivides the tube into two passages.

Numerous minute canals traverse the modiolus, and one more conspicuous than the others, the *central canal of the modiolus*, extends along its centre. The spiral lamina is also tunnelled by small canals in communication with those in the modiolus, whilst one, the *spiral canal of the modiolus*, winds spirally around the central pillar in the attached margin of the spiral lamina. All these channels convey filaments from the cochlear division of the auditory nerve to the membranous cochlea, whilst the spiral canal lodges the *ganglion spirale cochleæ*.

The *membranous cochlear tube* or *ductus cochlearis* is placed between the free margin of the spiral lamina and the opposite side of the wall of the cochlear tube. The two compartments of the bony cochlea are thus separated from each other, and they are respectively termed the scala tympani and the scala vestibuli. The *scala tympani* is the larger of the two. It begins at the fenestra rotunda, where the secondary membrane of the tympanum shuts it off from the tympanic cavity. At the apex of the cochlea it communicates by means of an aperture, termed the *helicotrema*, with the scala vestibuli. At the base of the cochlea the *scala vestibuli* communicates with the lower and fore part of the vestibule. The perilymph therefore, in the semicircular canals and vestibule, is directly continuous with that in the scala vestibuli and scala tympani.

It can now be easily understood how vibrations of the membrana tympani are communicated to the perilymph within the osseous labyrinth. The chain of auditory ossicles through the footpiece of the stapes affects the perilymph in the vestibule. The vibrations of the perilymph passing along the scala vestibuli into the scala tympani in turn affect the secondary membrane of the tympanum which is stretched across the foramen rotundum. With every inward movement of the membrana tympani and of the footpiece of the stapes, there is an outward movement of the membrane of the foramen rotundum and *vice versa.* The vibrations of the perilymph affect the endolymph in the membranous labyrinth, and thus excite the terminations of the auditory nerve.

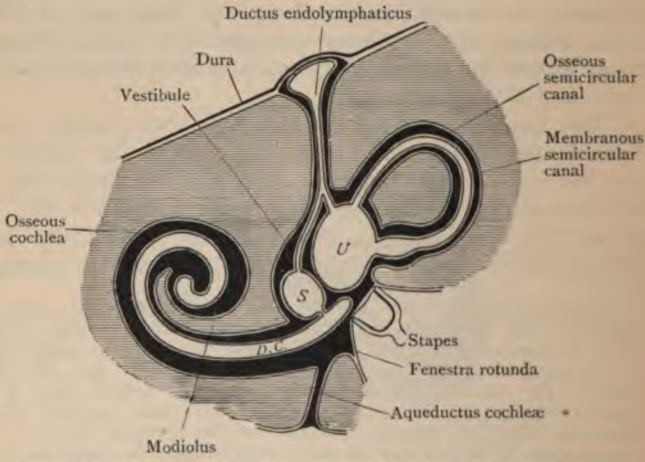

FIG. 231.—Diagram of the Osseous and Membranous Labyrinth. (Modified from Testut.)

U. Utricle. *S.* Saccule. *D.C.* Ductus cochlearis.

Membranous Labyrinth.—In the vestibule there are two membranous sacs termed the utricle and the saccule. The *utricle* occupies the fovea hemi-elliptica on the wall of the vestibule, and lies above and behind the saccule. Into it open the *membranous semicircular canals.*

The *saccule* is smaller, and occupies the fovea hemispherica on the forepart of the inner wall of the vestibule. It communicates by means of a short narrow tube, termed the *canalis reuniens*, with the ductus cochlearis or membranous cochlear tube.

The saccule and the utricle are only indirectly brought into communication with each other.

A slender tube termed the *ductus endolymphaticus* occupies the aqueductus vestibuli, and divides into two branches which pass respectively into the saccule and the utricle (Fig. 231).

The *ductus cochlearis*, or *scala media*, as we have already noted, lies between the two scalæ of the cochlear tube. It ends blindly at each extremity, but close to its basal end it is brought into communication with the saccule by the canalis reuniens.

THE EYEBALL.

THE eyeball is not perfectly spherical; it may be said to be composed of the segments of two spheres. The anterior or corneal segment, forming only about one-sixth of the entire eyeball, possesses a shorter radius than the hinder or sclerotic segment. The anterior clear corneal part of the eyeball forms, therefore, a dome-like bulging or prominence on the front of the globe of the eye. The terms *anterior* and *posterior pole* are respectively applied to the central points of the anterior and posterior segments of the eyeball. The imaginary line which joins these poles receives the name of the *sagittal axis*, whilst another line drawn in a coronal direction around the globe of the eye midway between the two poles so as to divide the eyeball into two hemispheres is termed the *equator*. Imaginary *meridional lines* are also drawn between the two poles so as to cut the equatorial line at right angles. In studying the structure of the eyeball it is necessary to have a proper understanding of these terms.

Dissection of the Eyeball.—A satisfactory dissection of the globe of the eye can only be made when the eyeball is fresh; and in the dissecting-room it is often impossible to obtain suitable specimens. This does not in reality matter very much, because it is always easy to procure eyeballs of the pig, sheep, or ox, which suit the purpose admirably. It is essential, however, that the dissector should always complete his study of the organ by the examination of a fresh human eyeball obtained from the *post-mortem* room. In point of size and also in other particulars the eyeball of the pig more closely resembles the human eyeball, but it is perhaps better that the student should begin with the eyeball of the ox, seeing that in it the dissection can be more easily carried out.

We shall suppose then that the dissector has provided himself with six eyeballs obtained from oxen. His first duty is to remove from these the conjunctiva, capsule of Tenon, ocular muscles, and fat, which adhere to them. Pinching up with the forceps the conjunctiva and capsule of Tenon close to the corneal margin, he should snip through these layers with the scissors and divide them completely round the edge of the cornea. It is now easy to strip all the soft parts from the surface of the sclerotic coat, working steadily backwards towards the entrance of the optic nerve. A little behind the equator of the eyeball the venæ vorticosæ will be noticed issuing from the sclerotic coat at wide intervals from each other, and on approaching the posterior aspect of the eyeball the posterior ciliary arteries and the ciliary nerves will be seen piercing the same coat around the entrance of the optic nerve.

Before beginning the actual dissection of the eyeball, it is important that the student should obtain a general conception of the parts which compose it. This can best be done by selecting two of the specimens and making sections through them in two different planes. One specimen may be divided at the equator into an anterior and a posterior portion, whilst the other may be divided in an antero-posterior direction into a mesial and a lateral half. To obtain satisfactory sections it is necessary that the eyeballs should in the first instance be hardened in a 15 per cent solution of formalin. When the sections are made, they should be placed under water in a cork-lined tray, and preserved for reference as the study of the eyeball is proceeded with.

General Structure of the Eyeball.—The eyeball consists of three concentrically arranged coats enclosing a cavity in which are placed three refracting media.

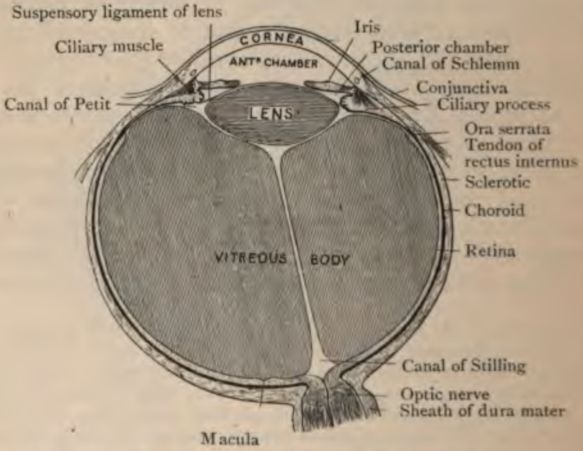
Suspensory ligament of lens
Ciliary muscle
Canal of Petit
CORNEA
ANT^R CHAMBER
LENS
Iris
Posterior chamber
Canal of Schlemm
Conjunctiva
Ciliary process
Ora serrata
Tendon of rectus internus
Sclerotic
Choroid
Retina
VITREOUS BODY
Canal of Stilling
Optic nerve
Sheath of dura mater
Macula

FIG. 232.—Horizontal section through the Left Eyeball. (Diagrammatic.)

The tunics are: (1) an external fibrous envelope composed of a posterior opaque part, called the *sclerotic coat*, and an anterior clear transparent portion called the *cornea*; (2) an intermediate vascular envelope, in which we recognise three subdivisions, viz., a hinder part called the *choroid coat*, a front portion termed the *iris*, which lies behind the cornea, and an intermediate *ciliary zone*; (3) the nervous inner tunic or *retina* in which the fibres of the optic nerve spread out.

The refracting media are: (1) behind the cornea a watery fluid, called the *aqueous humour*, contained in a space partially subdivided by the iris into the *two chambers of the eye*; (2) the *crystalline lens* behind this; and (3) the *vitreous* *body*, occupying the posterior part of the interior of the eyeball.

Dissection.—The superficial surface of the sclerotic coat and the cornea should now be examined; but to complete the study of the external tunic, a further dissection is required. Selecting an eyeball for this purpose, an incision should be made with a sharp knife through the sclerotic at the equator. This must be done carefully, and the moment that the subjacent black choroid coat appears the knife should be laid aside. The cut edge of the sclerotic should now be seized with the forceps, and the incision carried completely round the eyeball with the scissors along the line of the equator. The outer fibrous tunic is thus divided into an anterior and a posterior portion. These must now be raised from the subjacent parts. As the anterior portion is turned forwards, some resistance will be met close to the margin of the cornea from the attachment of the ciliary muscle to the deep surface of the sclerotic. This can easily be broken through with the blunt point of the closed forceps; as soon as this is done the aqueous humour escapes. In the case of the posterior part of the sclerotic, its complete separation can be effected by dividing the fibres of the optic nerve close to the point where they appear through the sclerotic.

When the above dissection is successfully carried out, the outer fibrous tunic is isolated in two portions, whilst a continuous view of the intermediate vascular coat is obtained. The eyeball, denuded of its external tunic, should now be placed in a shallow vessel filled with water.

Sclerotic Coat.—The sclerotic is what is commonly known as the white of the eye. It is a dense, resistant tunic, opaque-white in colour, which envelops the posterior five-sixths of the globe of the eye. It is thickest behind, and becomes thinner as it is traced forwards. Near the cornea, however, it again becomes thicker owing to the accession of fibres which it receives from the tendons of the ocular muscles. Except at the optic entrance and close to the margin of the cornea, where it adheres to the surface of the subjacent ciliary muscle, the deep surface of the sclerotic is very loosely attached to the choroid coat. Some pigmented flocculent connective tissue (lamina fusca) passes between the two coats and traverses what is in reality an extensive lymph space, termed the *perichoroidal space.*

The point at which the optic nerve pierces the back part of the sclerotic does not correspond with the posterior pole of the eyeball. The *optic entrance*, as it is termed, is situated about 3 mm. to the inner or nasal side of the posterior pole and very slightly below it. Here the outer fibrous sheath of the optic nerve, which is derived from the dura mater, blends with the sclerotic coat, whilst the bundles of nerve fibres are carried forwards through a series of small apertures. This perforated portion of the sclerotic is called the *lamina cribrosa.*

The sclerotic coat is also pierced by numerous blood vessels and nerves. Thus the long and short posterior ciliary arteries with the ciliary nerves perforate the sclerotic around the optic entrance; four or five venæ vorticosæ issue from the interior of the eyeball by piercing the sclerotic a little way behind the equator at wide intervals from each other; whilst the anterior ciliary arteries pierce the same coat near the corneal margin.

In front the sclerotic coat is not only contiguous with, but is directly and structurally continuous with, the cornea. This is termed the *corneo-scleral junction*, and the faint groove on the surface which corresponds with it receives the name of the *scleral sulcus*. At this junction the sclerotic tissue slightly overlaps the corneal tissue, so that the line of union when seen in section is oblique. Close to this a minute canal in the substance of the sclerotic, termed the *canal of Schlemm*, encircles the margin of the cornea.

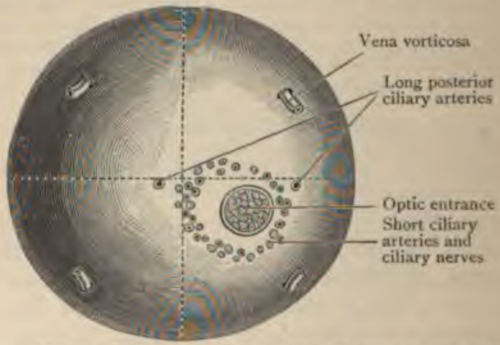
Vena vorticosa
Long posterior ciliary arteries
Optic entrance
Short ciliary arteries and ciliary nerves

FIG. 233.—Diagram of the posterior aspect of the Left Eyeball. The excentric position of the optic entrance is somewhat exaggerated. (After Testut, modified.)

Cornea.—The cornea forms the anterior sixth of the outer fibrous tunic of the globe of the eye. It is transparent and glass-like, and it forms the window through which the rays of light gain admittance into the eyeball. The curvature of the cornea is more accentuated than that of the sclerotic, and thus it constitutes the segment of a smaller sphere. When viewed from behind it appears circular, but when looked at from the front it is seen to be slightly wider in the transverse direction. This is due to the fact that the sclerotic overlaps it to a greater extent above and below than it does at the sides. This is particularly noticeable in the eyeball of the ox. The posterior concave surface of the cornea forms the front boundary of the anterior chamber of the eyeball, and is separated by the aqueous humour from the anterior surface of the iris.

The anterior convex surface of the cornea is clothed by the conjunctiva, which is here reduced to its epithelial layer. On its posterior aspect there is an elastic glassy stratum, termed the *elastic membrane of Descemet.* When the cornea is relaxed this membrane becomes wrinkled, and it can be torn away in shreds from the proper corneal tissue. When dealt with in this way the portions removed show a tendency to curl up.

Ligamentum Pectinatum Iridis.—At the margin of the cornea the membrane of Descemet becomes fibrillar, and some of its fibres are continued into the iris, forming the *pillars of the iris* or the *ligamentum pectinatum iridis,* whilst others are prolonged backwards into the choroid and the sclerotic. The ligamentum pectinatum iridis bridges across the angle between the cornea and the iris, and the bundles of fibres into which the membrane of Descemet breaks up in this region constitute an annular meshwork or sponge-like series of minute spaces termed the *spaces of Fontana.* These communicate with the anterior chamber of the eyeball, and are filled with lymph or aqueous humour.

Intermediate Vascular Tunic.—The intermediate or vascular tunic is exposed in its entire extent in the eyeball, from which the sclerotic coat and the cornea have been removed. As previously mentioned, the vascular tunic consists of three portions, viz., a choroid coat, a ciliary zone, and the iris. The *choroid coat* is the dark-coloured portion which lies behind the ciliary muscle. The *ciliary zone* consists of a superficial *ciliary muscle* and the subjacent *ciliary processes.* The ciliary muscle presents the appearance of a conspicuous white ring-like band, which encircles the fore-part of the eyeball immediately behind the corneo-scleral junction. The ciliary processes are directly continuous behind, under the ciliary muscle, with the choroid coat, and also in front with the iris. The *iris* is a circular curtain with a central aperture which lies behind the cornea.

Choroid Coat.—This is pierced behind by the optic nerve, and is somewhat thicker behind than it is in front. Its superficial surface is connected with the deep surface of the sclerotic by some lax connective tissue and also by blood vessels and nerves which pass from the one into the other. The deep surface of the choroid is moulded upon the retina and connected with a layer of deeply-pigmented cells, which usually adheres to the choroid when this tunic is removed, although in reality it must be regarded as a portion of the retina.

In the eyes of many mammals, but not in man, the posterior part of the choroid when viewed from the front presents an extensive brightly-coloured area, which exhibits a metallic lustre. This appearance is due to the presence of an additional layer in the choroid termed the *tapetum*. In the horse, elephant, ox, the tapetum is composed of fibres (tapetum fibrosum); in carnivora, it is formed of cells (tapetum cellulosum). In the ox, it is a brilliant green colour with a golden lustre; in the dog, it is white with a bluish border; in the horse, it is blue with a silvery lustre.

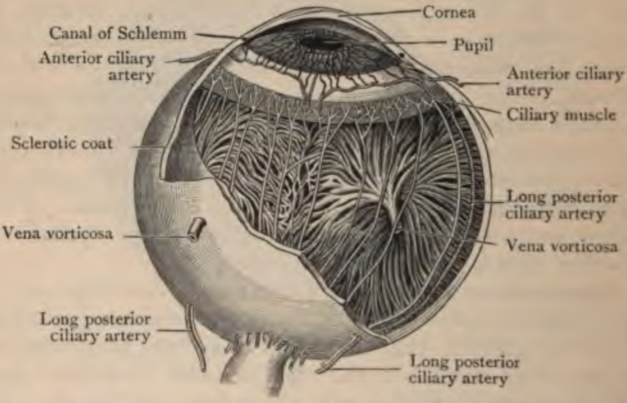
Cornea
Canal of Schlemm
Pupil
Anterior ciliary artery
Anterior ciliary artery
Ciliary muscle
Sclerotic coat
Long posterior ciliary artery
Vena vorticosa
Vena vorticosa
Long posterior ciliary artery
Long posterior ciliary artery

FIG. 234.—Dissection of the Eyeball showing the Vascular Tunic and the Distribution of the Ciliary Nerves and Vessels.

The chief bulk of the choroid coat is composed of blood vessels. These are arranged in two well-marked layers, viz., a deep, closely-meshed capillary layer called the *tunica chorio-capillaris* or the *tunica Ruyschiana*, and a more superficial venous layer composed of the *vasa vorticosa*. The short posterior ciliary arteries proceed forwards between these vascular layers.

The eyeball in which the outer surface of the choroid is exposed should be immersed in water and the pigment washed out of it by means of a camel-hair brush. The vasa vorticosa will then appear as white curved lines converging towards four or five points, from which the larger venæ vorticosæ take origin (Fig. 234).

Ciliary Muscle.—This is composed of involuntary muscular tissue, but the arrangement of its fibres can only be seen when thin sections of the eyeball are examined under the microscope. The fibres are then observed to be disposed in two groups, viz., a radiating and a circular.

The *radiating fibres* arise from the deep aspect of the sclerotic coat close to the margin of the cornea. From this they radiate backwards in a meridional direction, and gain insertion into the choroid coat in the region of the ciliary processes.

The *circular fibres* consist of two or three bundles placed upon the deep aspect of the radiating portion of the muscle. They form a muscular ring around the circumference of the iris.

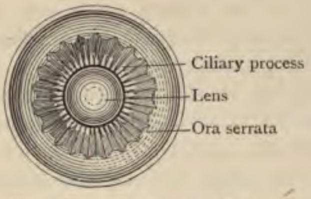

FIG. 235.—The Ciliary Processes of the Human Eyeball, viewed from behind. (From Merkel.)

Dissection.—To obtain a view of the ciliary processes, a coronal section should be made with the scissors through an eyeball a short distance in front of the equator. The portion of the vitreous body which occupies the anterior segment of the eyeball should be carefully removed. When this is done, the deep aspect of the ciliary processes will be seen as they radiate backwards from the circumference of the crystalline lens. By washing out the pigment from this part of the vascular tunic, the arrangement of the processes will be more fully displayed.

A second dissection may be made in another eyeball with the object of exposing the ciliary processes from the front. In this case remove the cornea with the scissors by cutting round the corneo-scleral junction. The iris is now brought conspicuously into view, and may, with advantage, be studied at this stage. Several cuts in the meridional direction, and at equal intervals from each other, should in the next place be made through the anterior part of the sclerotic coat. The strips of sclerotic should then be separated from the ciliary muscle, and pinned backwards in a cork-lined tray filled with water. The last step in the dissection consists in the removal of the iris.

Ciliary Processes.—When the choroid coat is traced forwards under the ciliary muscle, it is seen to form a series of elongated prominent thickenings, which radiate backwards from the margin of the crystalline lens like the folds of a goffered frill. These thickenings are the ciliary processes. They vary slightly in their degree of prominence, and also in length, but they are very constant in number. In the human eye seventy ciliary processes, as a rule, may be counted. As each process proceeds forwards, it becomes gradually more and more prominent, until ultimately it ends in a thickened projection, which occupies the space between the margin of the iris and the circumferential part of the anterior surface of the crystalline lens. In this position the ciliary processes bound peripherally the posterior chamber of the eyeball (Fig. 236).

The ciliary processes rest upon the subjacent zonule of Zinn, *i.e.*, the membrane which covers the fore-part of the vitreous body. This membrane is adapted in the most intimate manner to the ciliary processes. It is folded or wrinkled in such a way that the folds occupy the sulci or valleys between the processes.

Iris.—The iris lies in front of the crystalline lens, and it is separated from the cornea by the anterior chamber filled with aqueous humour. By its circumference it is continuous with the ciliary body, and it is at the same time connected by the ligamentum pectinatum iridis with the margin of the cornea.

The iris is circular in form, and is perforated in the centre by a round opening which is termed the *pupil.* Its anterior surface is faintly striated in a radial direction. It is coloured differently in different individuals. Its posterior surface is deeply pigmented. The pupil presents a very nearly circular outline,[1] and during life it constantly varies in its dimensions so as to control the amount of light which is admitted into the interior of the eyeball. These changes in the size of the pupil are produced by the contractile properties of two groups of involuntary muscular fibres which are present in the substance of the iris. One group is composed of muscular fibres arranged circularly around the pupil in the form of a *sphincter*; the second group consists of fibres which have a radial direction, and pass from the sphincter towards the circumference of the iris, so as to constitute a *dilatator*

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[1] It may be as well to mention here that the pupil in the ox and the sheep is greatly elongated in the transverse direction. In the pig, how-ever, it is approximately circular.

muscle. By certain anatomists these radial fibres are considered to be *elastic* and not *muscular.*

Ciliary Nerves.—The ciliary nerves which arise from the lenticular ganglion and the nasal nerve, after piercing the sclerotic at the back of the eyeball around the optic entrance, extend forwards between this coat and the choroid in the perichoroidal lymph space. They will be seen in the specimen in which the sclerotic has been turned backwards in separate flaps in the form of delicate white filaments (Fig. 234). In the posterior part of the eyeball they occupy grooves on the deep surface of the sclerotic, and can only be separated from it with difficulty. Reaching the ciliary zone the ciliary nerves break into branches, which join in a plexiform manner and send twigs to the ciliary muscle, the iris, and the cornea.

Ciliary Arteries.—Of these we recognise three groups, viz.:—(1) the short posterior ciliary arteries; (2) the long posterior ciliary arteries; and (3) the anterior ciliary arteries.

The *short posterior ciliary arteries*, branches of the ophthalmic, pierce the sclerotic around the optic entrance, and are distributed in the choroid coat between the vasa vorticosa and the membrana chorio-capillaris.

The *long posterior ciliary arteries*, also branches of the ophthalmic, are only two in number. They perforate the sclerotic on either side of the optic nerve (Fig. 234), a short distance beyond the short ciliary arteries, and are then carried forwards between the sclerotic coat and the choroid. When they gain the ciliary zone each artery divides into an ascending and a descending branch, and these, with the anterior ciliary arteries, form an arterial ring termed the *circulus iridis major.* From this branches are given to the ciliary muscle, the ciliary processes, and the iris.

The *circulus iridis minor* is the name applied to a second arterial ring in the iris at the outer border of the sphincter pupillæ.

The *anterior ciliary arteries* are very small twigs, which arise from the branches of supply to the recti muscles. They pierce the sclerotic close to the margin of the cornea, take part in the formation of the circulus iridis major, and send twigs to the ciliary processes.

Venæ Vorticosæ.—From each venous vortex in the choroid a large vein arises, which makes its exit from the eyeball by piercing the sclerotic obliquely a short distance behind the equator. They are four or five in number.

Dissection.—The vitreous body and retina in the hinder part of the eyeball, which was cut into two for the purpose of exposing the ciliary processes from behind, should now be dislodged. By raising the choroid coat from the deep surface of the sclerotic, under a flow of water from the tap, the venæ vorticosæ entering the deep surface of the sclerotic will be brought into view. When these are divided, and the separation of the two coats is carried back towards the optic entrance, the posterior short ciliary arteries, as they emerge from the sclerotic and enter the back part of the choroid, will be seen.

In the eyeball from which the sclerotic and cornea have been removed, the iris, ciliary processes, and the choroid should be carefully stripped off piecemeal under water. This will expose the retina.

Retina.—The retina is composed of two strata—viz., a thin *pigmentary layer*, which adheres to the deep surface of the choroid coat, and has been removed with it, and a delicate *nervous layer*, which is moulded on the surface of the vitreous body, but presents no attachment to it except at the optic entrance. The retina extends forwards beyond the equator of the eyeball, and a short distance from the ciliary zone it appears to end in a well-defined wavy or festooned border termed the *ora serrata*. This appearance, however, is somewhat deceptive. The nerve elements, it is true, come to an end along this line, but a lamina in continuity with the retina is in reality prolonged forwards as far as the margin of the pupil. The part in relation to the ciliary processes is exceedingly thin, and cannot be detected by the naked eye. It is termed the *pars ciliaris retinæ*. The portion on the deep surface of the iris forms its posterior *uveal pigmentary layer* (pars iridica retinæ).

During life the *retina proper* is transparent, but after death it soon assumes a dull greyish tint and becomes opaque. Posteriorly it is tied down at the optic entrance. When viewed from the front this appears as a conspicuous circular disc termed the *porus opticus* or *optic disc*. From this spot the optic nerve fibres radiate out so as to form the deep or anterior layer of the retina. The optic disc, in correspondence with the entrance of the optic nerve, lies to the inner or nasal side of the antero-posterior axis of the eyeball. Exactly in the centre of the human retina, and therefore in the axis of the globe of the eye, there is a small yellowish spot termed the *macula lutea*.[1] It is somewhat oval in outline, and in its centre it is depressed, thereby forming what is called the *fovea centralis*.

Retinal Arteries and Veins.—In a fresh eyeball the *arteria retinæ centralis* will be seen entering the retina at the optic disc. It immediately divides into an ascending and a descending branch, and each of these breaks up into a large outer or temporal division, and a smaller inner or nasal division. These ramify in the retina as far as the ora serrata; but the resultant branches do not anastomose with each other nor with any of the other vessels in the eyeball.

The *retinal veins* converge upon the optic disc, and disappear into the substance of the optic nerve in the form of two small trunks which soon unite.

The retinal vessels, the optic disc, and the macula can all be examined in the living eye by means of the ophthalmoscope. The red reflex obtained from the fundus of the eyeball is produced by the blood in the membrana chorio-capillaris.

Dissection.—For the study of the vitreous body and the crystalline lens, which together may be termed the "eye-kernel," it is better to take an eyeball which is not perfectly fresh (Anderson Stuart). The eyeball selected for this purpose should be allowed to stand untouched from one to three days according to the season. The coats of the eye should then be divided round the equator, and on gently separating the cut edges, and turning the coats forwards and backwards, the "eye-kernel" will slip out. It should be allowed to drop into a vessel filled with clean water. The examination of the parts forming the eye-kernel will be greatly facilitated by placing it *en masse* in strong picro-carmine solution for a few minutes. When removed from the staining fluid, it should be well washed in water. In this way the hyaloid membrane enclosing the vitreous body, the capsule of the lens, and the zonula of Zinn, are stained red, and their connexions become very apparent (Anderson Stuart).

Vitreous Body.—This is a soft, yielding, perfectly transparent jelly-like body, which occupies the posterior four-fifths of the interior of the eyeball. The retina is spread over its surface as far forwards as the ora serrata, but is in no way attached to it, except at the optic disc. In front of the ora serrata, the ciliary processes are applied to the vitreous body and indent its surface. Anteriorly, the vitreous body is hollowed out, and presents a deep concavity, the *fossa patellaris*, for the reception of the posterior convex surface of the crystalline lens.

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[1] There is no macula lutea in the eyeball of the ox or sheep.

The substance of the vitreous body is enclosed within a delicate transparent membrane, which completely envelops it, and receives the name of the *hyaloid membrane.* Extending forwards through the midst of the vitreous mass from the region of the optic disc to the back of the crystalline lens is a minute canal, lined by a tube-like prolongation of the hyaloid membrane, and containing a watery fluid. This is termed the *hyaloid canal*, or the *canal of Stilling*, and it represents the path which was taken by a branch of the arteria retinæ centralis, which in the fœtus extends forwards for the supply of the capsule of the lens, but afterwards disappears.

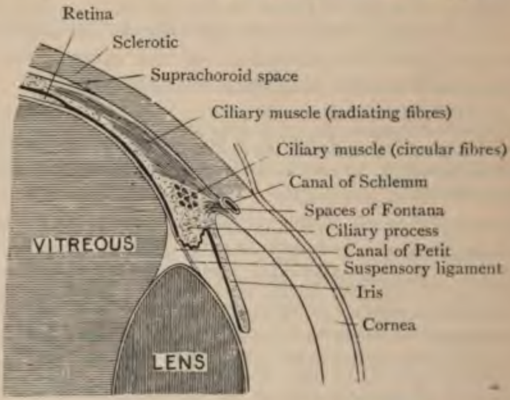
Retina
Sclerotic
Suprachoroid space
Ciliary muscle (radiating fibres)
Ciliary muscle (circular fibres)
Canal of Schlemm
Spaces of Fontana
Ciliary process
Canal of Petit
Suspensory ligament
Iris
Cornea
VITREOUS
LENS

FIG. 236.—Diagrammatic representation of the Ciliary Region, as seen in vertical section.

The canal of Stilling, as a rule, cannot be seen in an ordinary dissection of the eyeball; but if the eye-kernel be shaken up in the picro-carmine solution as recommended by Anderson Stuart, it may sometimes be rendered evident through the staining fluid entering it.

Zonula of Zinn and the Suspensory Ligament of the Lens.—In the ciliary region the hyaloid membrane of the vitreous body becomes thickened and strengthened, and forms what is termed the zonula of Zinn. As this approaches the margin of the crystalline lens, it splits into two parts, viz., an exceedingly delicate deep lamina, which lines the fossa patellaris, and a more superficial stronger part, which becomes attached to the capsule of the crystalline lens.

The zonula of Zinn lies subjacent to the ciliary processes, and is radially plaited or wrinkled in correspondence with these. Thus the elevations or wrinkles of the zonula extend into the intervals between the ciliary processes, whilst the ciliary processes in their turn lie in the depressions between the wrinkles of the zonula. When the eye is fresh, these opposing parts are closely adherent.

The zonula of Zinn is strengthened by radially directed meridional elastic fibres, and after the delicate membrane which lines the fossa patellaris is given off from its deep surface, it extends forwards as a distinct layer, and is attached to the anterior surface of the capsule of the lens a short distance beyond the margin of that body. In this manner the *suspensory ligament of the lens* is formed. But this is not the only attachment of the suspensory ligament. Some scattered fibres are attached to the circumference or equator of the lens (equatorial fibres), whilst others are fixed to its posterior surface close to its margin (post-equatorial fibres).

In this way the crystalline lens is firmly held in its place in the fossa patellaris. Further, the degree of tension of its suspensory ligament is influenced by the radiating fibres of the ciliary muscle, which by their contraction pull upon the ciliary processes, and produce relaxation of the zonula of Zinn.

Canal of Petit.—This is a circular lymph space, which surrounds the circumference of the lens. It is bounded in front by the suspensory ligament, and behind by the hyaloid membrane, enclosing the vitreous body. It is filled with a watery fluid.

By introducing the point of a fine blow-pipe into the canal of Petit through the suspensory ligament, it can be partially, or, perhaps, completely, inflated with air. It then presents a sacculated appearance.

Dissection.—The crystalline lens may be removed by snipping through the suspensory ligament with scissors.

Crystalline Lens.—The crystalline lens is a biconvex, solid, and transparent structure, which lies behind the iris, and in front of the vitreous body. It is enclosed within a glassy, elastic capsule, to which the different parts of the suspensory ligament are firmly cemented, and it presents for study an anterior surface, a posterior surface, and a circumference or equator.

The *anterior surface* is not so highly curved as the posterior surface. Its central part which corresponds with the pupillary aperture of the iris looks forward into the anterior chamber of the eye. Around this part the margin of the pupillary orifice of the iris is in contact with the lens, whilst nearer the equator the anterior surface of the lens is separated from the iris by the fluid in the posterior chamber of the eyeball. The *posterior surface* of the lens presents a higher degree of curvature than the anterior surface, and is received into the fossa patellaris of the vitreous body. The *equator* or *circumference* is rounded. It forms one of the boundaries of the canal of Petit, and the manner in which the suspensory ligament is attached to the capsule in this vicinity has already been described.

Faint radiating lines may be seen on both surfaces of the lens. These give a clue to the structure of the lens. They indicate the planes along which the extremities of the lens-fibres come into apposition with each other.

The *capsule* of the lens is a resistant glassy membrane, which is considerably thicker in front than behind.

The anterior wall of the capsule may now be divided with a sharp knife. A little pressure will cause the body of the lens to escape through the opening. The stained capsule, whilst floating in water, can be very advantageously studied.

If the lens body be compressed between the finger and thumb, it will be observed that the outer portion or cortical part is soft, whilst the central part or *nucleus* is distinctly firmer. When the lens is hardened in alcohol it can easily be proved that it is composed of numerous concentrically arranged laminæ.

Chambers of the Eyeball.—The *anterior chamber* of the eyeball is the space between the cornea in front, and the iris and central part of the lens behind. At the irido-corneal angle, it is bounded by the ligamentum pectinatum, and here the aqueous humour which fills this chamber finds access to the spaces of Fontana.

The *posterior chamber* is a circular space or interval which is bounded in front by the posterior surface of the iris, and behind by the circumferential part of the anterior face of the lens. Externally, this space is closed by the thick anterior projecting ends of the ciliary processes. It is also filled with aqueous humour.

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[illegible] exam

1. Describe the outer & inner ends of the clavicle, giving their shape & chief features.

2. With what bones [illegible] articulate? What important [illegible] articles?

3. Describe [illegible] forming a part of the wall of [illegible]

4. Describe [illegible]

5. Give the course of the [illegible] What are the most imp. branches?

6. Describe the [illegible] lower border [illegible]

7. [illegible] what nerve [illegible] What does it supply?

8. [illegible]

9. What are the surfaces [illegible]

10. Give the relations of the [illegible] of the aorta

11. From where does the [illegible] Give its course.

Describe [illegible]

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[illegible] exam

1. Describe the outer & inner ends of the classes, giving their shape & chief features.

2. With what [illegible] did [illegible] against [illegible] & what
what Importance did [illegible] date [illegible]?

3. [illegible] into [illegible] called [illegible]

4. [illegible]

5. Give the [illegible] of the [illegible]
which [illegible] most imp[illegible]

6. [illegible] the [illegible] The
Greek [illegible]

[illegible] what [illegible]
What does it signify?

[illegible]

9. What [illegible]

[illegible] of the [illegible]

[illegible]?

(1) Frontal (4)
(1) Sphenoid (4)
(2) Ethmoid
Malar (4)

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[illegible]

1. Describe the outer & inner ends of the clavicle, giving their shape & chief features.

2. With what bones does [illegible] articulate? What important [illegible] attached?

3. Describe [illegible] joints forming a part of the wall of pelvis

4. Describe [illegible] Magendie [illegible]

5. Give the course of the [illegible] in the skull. What are its most imp. [illegible]?

6. Describe the pyramidal body [illegible] the lower border of the medulla [illegible]

7. From what nerve roots [illegible] What does it supply?

8. Describe the [illegible]

9. What are the surfaces [illegible]?

10. Give the relations of the [illegible] the arch of the aorta

11. How & where does the [illegible] duct begin? Give its course.

Describe the [illegible]